APPENDIX J

AIR EMISSION INVENTORY

JACKSONVILLE HARBOR NAVIGATION (DEEPENING) STUDY

DUVAL COUNTY, FLORIDA

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Jacksonville Harbor Deepening Project

Jacksonville Harbor Estimated Air Quality Emissions Inventory
Existing Condition and Future Emissions Estimates

For
US Army Corps of Engineers
Jacksonville District

By

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April 2013

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1.0 INTRODUCTION

The Jacksonville Harbor (Figure 1.1) includes both publicly and privately owned terminals and services a variety of vessel types and cargos. The harbor, strategically located with respect to international ship traffic and the continental US may benefit from ongoing changes that will allow larger vessel traffic across the world. A USACE Draft Supplementary Environmental Impact Statement (DSEIS) is currently considering the effects of deepening the federal ship channel for Jacksonville Harbor. This air quality analysis comprises one component of the EIS.

The publicly owned JAXPORT controls three terminals within the harbor — Blount Island Marine Terminal, Dames Point Marine Terminal, and Talleyrand Marine Terminal. Blount Island Marine Terminal, JAXPORT's largest marine facility, covers 754 acres. This terminal, one of the largest vehicle import/export centers in the US, handles RORO (roll-on / roll off), heavy lift, breakbulk, and liquid bulk cargoes. The Dames Point Terminal, built in 2010, covers 585 acres. JAXPORT's newest facility, The Dames Point Terminal locates 10 nautical miles from the Atlantic Ocean. This terminal handles containers, bulk aggregate materials and serves as a cruise ship terminal. The Talleyrand Terminal, 173 acres and more than 20 miles from the river mouth, handles containerized and breakbulk cargoes, imported automobiles, and liquid bulk commodities.

In addition to the JAXPORT terminals, the harbor includes 17 private or proprietary marine terminals along the St. Johns River (Table 1.1). Of those terminals

- Peeples Terminal will be built in future
- Celotex and Apex Terminals are out of business as of the year 2013
- Chevron Terminal will be purchased by Centerpoint Terminal
- Marathon and BP Terminals will be purchased by Blanchard Terminal.

Figure 1.1 shows the location of the JAXPORT and private terminals within Jacksonville Harbor

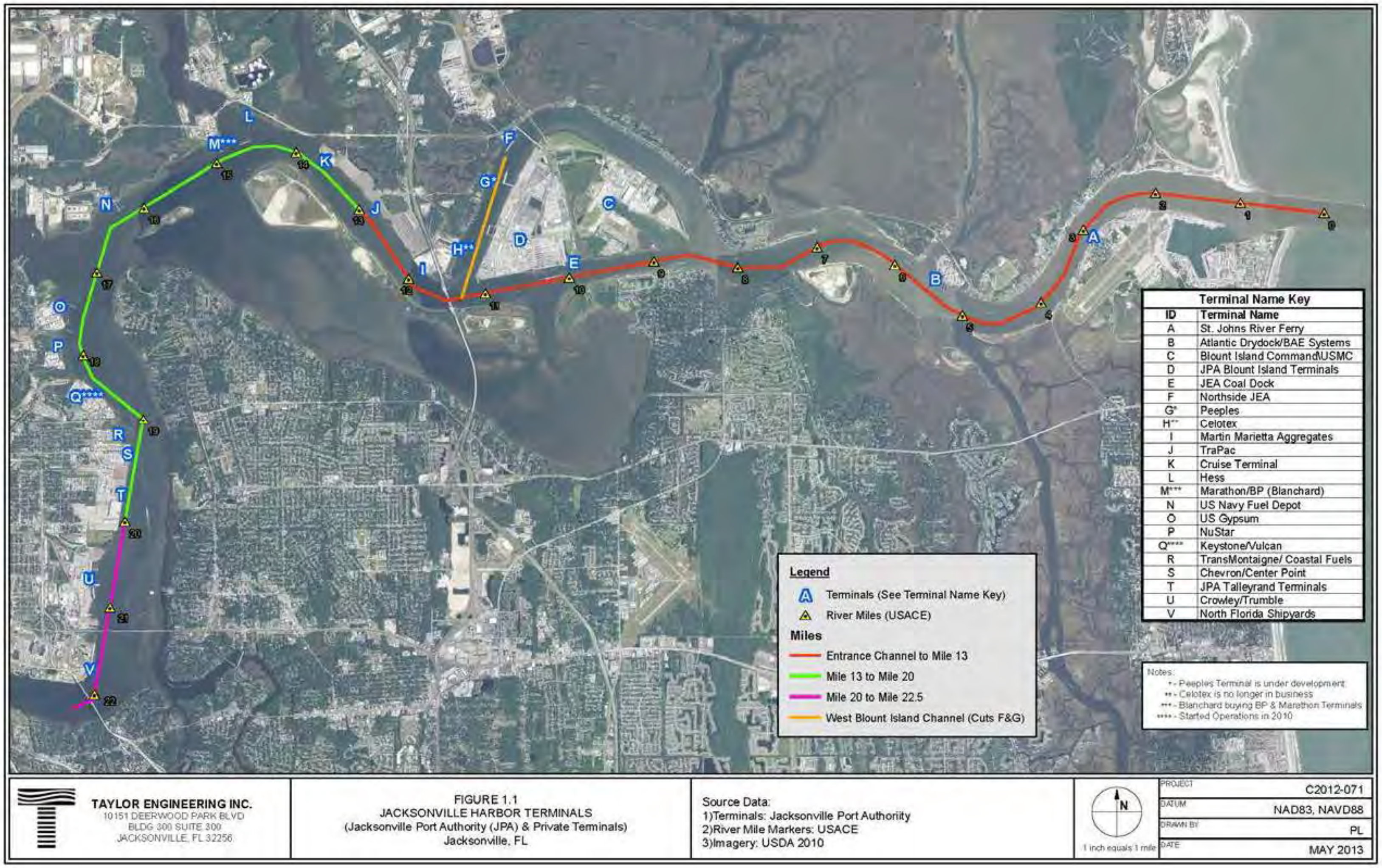


Table 1.1 Privately Owned Terminals in Port of Jacksonville

Atlantic Dry Dock/BAE Systems	Blount Island Command/ U.S Marine Corps	Jacksonville Electric Authority (JEA) Coal Dock
Jacksonville Electric Authority (JEA) Northside Terminal	Peeples	Celotex
Hess Oil	Marathon/BP/Blanchard Terminal	U.S Navy Fuel Depot
U.S Gypsum	NuStar	Keystone/Vulcan
TransMontaigne/Coastal Fuels	Chevron/Centerpoint	Crowley
Apex	North Florida Shipyard	

Figure 1.1 JAXPORT and Private Terminals within Jacksonville Harbor

Economic projections indicate a likely increase in containerized shipping throughout the world, along the US East Coast, and in the Port of Jacksonville (Jacksonville Port Authority, 2012). In response to this growth in container volume, the shipping industry will likely continue its trend toward larger container vessels. The planned deepening of the Panama Canal will allow the use of these larger vessels on routes serving the eastern US. Vessels requiring the larger locks and channels of the deepened Panama Canal system are referred to as “Post-Panamax” (Table 1.2). Jacksonville Harbor can accommodate all vessels shown in Table 1.2 except the fully loaded Post-Panamax size, which drafts significantly more than the current authorized channel depth of – 40 feet MLLW (Mean Low Low Water). Panamax and Post-Panamax vessels with lower loads, which draft at 42 feet, can enter the channel during specific tidal conditions.

Table 1.2 Container Vessel Characteristics/Physical Specifications

Ship Class	Overall Length (feet)	Beam (feet)	Draft (feet)	TEU Capacity
Post-Panamax	1,044.0	140.0	46	>=6,000
Panamax	951.0	106.0	42	4,000
Sub-Panamax	716.3	100.0	38	2,500
Handy Size	610.7	85.1	32	1,600

*TEU – Twenty-Foot Equivalent Unit

With a desire to accommodate fully loaded Post-Panamax vessels within the Jacksonville Harbor, the USACE-Jacksonville District, in collaboration with JAXPORT and other local partners, is conducting a harbor deepening study. This study will identify a suitable water depth required to deepen the St. Johns River within the harbor that would allow the safe movement of Post-Panamax vessels. The study includes an extensive environmental impact analysis to determine the effects of the harbor deepening project on the environmental conditions (including air quality) within the harbor and surrounding areas.

USACE contracted Taylor Engineering to conduct an air emission inventory of the items that contribute to air quality within the Jacksonville Harbor.

2.0 OBJECTIVE

The detailed air quality assessment will evaluate the air emissions (including air toxics) from cargo-carrying vessels, harbor support vessels, and landside fleet and equipment at JAXPORT terminals and privately operated terminals within the harbor. It will also compare the emissions for both the “With-Project” (i.e., -44, -45, -47, -48-foot water depths) and “Without-Project” (No-Action) alternative (i.e., -40-foot existing water depth) for the years 2020, 2030, 2040, 2050, 2060, and 2070. The assessment does not inventory every air pollutant-emitting device; JAXPORT and the private terminals do not currently collect data to that level of detail. Where necessary, this analysis applies conservative estimates in place of observed data. The assessment does not include a hot spot emissions analysis, a detailed dispersion modeling assessment of these emissions, or a risk-based assessment of the health effects associated with the proposed project. The primary focus of this work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the status of air quality in the Jacksonville area.

For the purposes of this assessment, the area defined for vessel emissions is consistent with the area considered in the U.S Environmental Protection Agency's (USEPA) "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report" (USEPA, 2009).

For ocean-going vessels, the area begins in the ocean about a half mile east of St. Johns Lighted RACON buoy (STJ) where the harbor pilots join the vessel to pilot it on its inland transit, and extends to wherever the vessel docks to load or discharge its cargo. On land, the area includes the terminals and the local distances as defined in USEPA (2009) driven by trucks transporting cargo to and from the port.

Emission calculations use the period beginning when a vessel travels beyond STJ toward the harbor and ending when it passes STJ outwardly bound. The outbound trip emissions are assumed the same as the inbound emissions. The analysis considers vessel travel to from the STJ to the initial terminal destination), shifts within the port (between terminals), and tugs that assist in docking and in shifts between terminals. On land, emissions include the port equipment used to load and unload cargo from the vessels, and then move that cargo around and beyond the terminal. For container cargo, the emissions consider the time trucks wait to enter the terminal, their typical operating behaviors within the terminals while they drop off or pick up their loads, as well as the location/time for the outgoing trucks to clear the immediate vicinity of the port and the City of Jacksonville limits. The air emission assessment also estimates emissions from operation of the St. Johns Ferry Service, which transports vehicles and passengers within the harbor.

This emissions inventory and assessment is based on information provided by USACE, JAXPORT, Jacksonville Marine Transportation Exchange (JMTX), St. Johns River Harbor Pilots Association, tugboat companies operating in the harbor, private terminals, company websites, and the USEPA. Taylor Engineering obtained the vessel call data and fleet forecast data from USACE Jacksonville District. Taylor Engineering supplemented this information with USACE Jacksonville District dredging records as well as dredging projections developed by the USACE as part of the National Economic Development (NED) analysis for the Jacksonville Harbor Deepening Project.

The JAXPORT and JMTX staff conducted much of the local "leg work" for this analysis, contacting various equipment owners and operators to obtain information needed to conduct the emissions assessment. Without their assistance, this analysis would not contain such detailed, accurate information. Staff from USACE Jacksonville District coordinated with USEPA and City of Jacksonville to obtain existing air pollutant inventories for Duval County and City of Jacksonville. In cases where detailed information was unavailable, best professional judgment provided an estimate of the missing information. This report records all decisions to estimate emissions.

3.0 METHODOLOGY FOR DETERMINING AIR EMISSIONS

The USEPA report “Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report” (USEPA, 2009) provided the framework to estimate air emissions for the Port of Jacksonville. The expanded analysis followed a Mid-Tier approach (Figure 3.1 reproduced from USEPA, 2009, Figure 2-3).

The air emission analysis followed USEPA’s overall evaluation process. In general, air emission calculations use the size of an engine, the amount of time the engine is used, the load upon the engine, and the emission rate for that type of pollutant and engine. Many details can affect the final calculated value, including at least the age of the engine and the type of fuel that it burns.

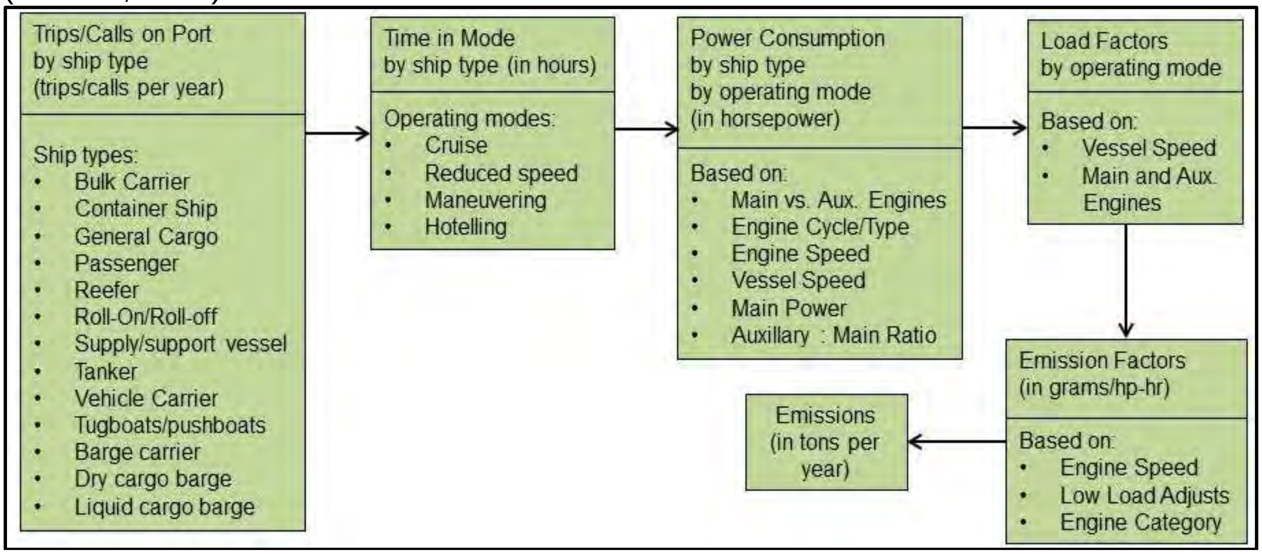
Developing an air emission inventory using USEPA’s Mid-Tier approach (Figure 3.1) first requires determination of the vessel types and calls per year at the port. Attachment A shows the existing vessel call and vessel fleet forecasts developed by the USACE Jacksonville District. USACE, JAXPORT, JMTX and the Harbor Pilots provided the number and types of vessels calling at the port for the No-Action alternative or baseline depth (i.e., -40 feet) and alternative depths (i.e.,-44, -45, -47, and -48 feet) for the years 2020 to 2070.

The fleet forecast provided the numbers and types (Post-Panamax, Panamax, Sub-Panamax, and Handy size) of vessels calling at the port under different harbor deepening alternatives. Projections provide vessel calls for every 10 years, 2020 to 2070 (inclusive). USACE assumed that the Port of Jacksonville will reach capacity in 2040 and the vessel forecast information for year 2040 would be same for years between 2040 and 2070.

Taylor Engineering first calculated air emissions for each vessel engine size (both main and auxiliary engines working under various loads at different times with different fuels) for all depths and years. Harbor craft (tugs, river ferry, etc.), harbor shifts (vessel movements from one terminal to another), and dredging operations (includes both maintenance and deepening work) emissions were calculated using methodologies stated in USEPA (2009).

JAXPORT provided equipment data and usage for its land-based operations at Blount Island, Dames Point and Talleyrand terminals. Taylor Engineering calculated the air emissions for land-based operations (cargo handling equipment, trucks going into and out of the terminals, fleet vehicles, and trains) for all terminals using the formulas and methods discussed in USEPA (2009).

Figure 3.1 U.S. USEPA Flow Chart for Mid-Tier Air Emission Inventory Preparation (USEPA, 2009)



After calculating vessel and land-based emissions for the terminals within the Port of Jacksonville for all depths and years, Taylor Engineering calculated the amount of air toxics emitted for these depths and years. Air toxics are generally determined as a ratio of criteria pollutant discharges. The air toxic emission rates are a proportion of other criteria pollutant parameters such as VOC or PM10 components of a total pollutant load. Taylor Engineering obtained toxics ratio information from the USEPA's National Mobile Inventory Model (NMIM) Source Classification Code (SCC) database (USEPA, 2012).

Taylor Engineering calculated emission loads from the nine sources for the following criteria pollutants:

- Nitrous Oxide (NO_x)
- Carbon Monoxide (CO)
- Hydro Carbon (HC)
- Particulate Matter less than 10 microns (PM 10)
- Particulate Matter less than 2.5 microns (PM 2.5)
- Sulfur Dioxide (SO_2)
- Carbon Dioxide (CO_2)
- Volatile Organic Carbons (VOC)

In summary, Taylor Engineering estimated air emissions from nine different sources directly associated with operations of the harbor. The total emission load included emissions from the three JAXPORT terminals and the 13 private terminals located within the harbor. The emission inventory included the ocean-going vessels that call at various terminals within the harbor, the tugs that assist these vessels, the landside equipment that moves the cargo in the terminals, ancillary vessels which operate in the harbor (dredges and river ferry boats), and equipment used to move containers out of the harbor area.

4.0 BASELINE AND ESTIMATED FLEET FORECAST FOR JACKSONVILLE HARBOR

The USACE Jacksonville District, JAXPORT, JMTX and St. Johns Bar Pilots Association worked together to develop the one-way vessel call information arriving at JAXPORT terminals and private terminals (also referred to as non-JAXPORT terminals). Taylor Engineering chose USEPA's published values of emission loads from various criteria pollutants for Duval County for the year 2008 as the baseline year for emission calculations. This allows comparing the emission loads from the existing Jacksonville Harbor operations with the USEPA's estimated emission loads for the year 2008.

To develop the baseline one-way vessel call data for the year 2008, Taylor Engineering averaged the existing one-way vessel call information for years 2008 – 2010 for JAXPORT terminals and private terminals (Tables 4.1 – 4.4). The vessel calls for the year 2008 would not have included the increase in vessel call data at Dames Point Terminals since the Trapac container and bulk terminal within JAXPORT's Dames Point Terminal began operations in 2009. Since 2009, the Dames Point Terminal has seen an increase in vessel calls. Hence, the three-year average of vessel calls at all terminals (JAXPORT and non-JAXPORT) provided a more reasonable baseline dataset for comparison to fleet forecasts.

Tables 4.1 – 4.4 show the average one-way vessel calls for the baseline year of 2008 for JAXPORT terminals (Blount Island Terminal, Dames Point Terminal, and Talleyrand Terminal) and for all non-JAXPORT terminals combined. The Port of Jacksonville received 2,309 ocean going vessel calls for the baseline year of 2008.

Table 4.1 Three-Year Average One-Way Vessels Calls to Blount Island Terminal

Vessel Category	Handysize	SubPanamax	Panamax	Post Panamax	Total
Bulk Carrier	4	7	-	-	11
Container	27	21	128	34	210
Cruise	0	-	-	-	0
Dry Cargo Barge	141	2	98	-	241
General Cargo	87	16	-	-	104
Reefer Cargo	2	-	-	-	2
RoRo Cargo	25	8	154	-	188
Tanker	1	1	0	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier	21	390	8	-	419

Table 4.2 Three-Year Average One-Way Vessels Calls to Dames Point Terminal

Vessel Category	Handysize	Sub Panamax	Panamax	Post Panamax	Total
Bulk Carrier	0	14	14	-	28
Container	-	0	11	65	76
Cruise	2	-	34	-	36
Dry Cargo Barge	1	-	-	-	1
General Cargo	-	-	-	-	-
Reefer Cargo	-	-	-	-	-
RoRo Cargo	-	-	0	-	0
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier	0	6	-	-	6

Table 4.3 Three-Year Average One-Way Vessels Calls to Talleyrand Terminal

Vessel Category	Handysize	Sub Panamax	Panamax	Post Panamax	Total
Bulk Carrier	2	2	1	-	**5**
Container	73	24	78	9	**184**
Cruise	0	-	-	-	**0**
Dry Cargo Barge	6	83	172	-	**262**
General Cargo	102	16	-	-	**118**
Reefer Cargo	14	-	-	-	**14**
RoRo Cargo	1	7	8	-	**16**
Tanker	10	13	1	-	**24**
Tanker Barge	-	-	-	-	**-**
Vehicle Carrier	1	85	-	-	**86**

Table 4.4 Three-Year Average One-Way Vessels Calls to All Private Terminals

Vessel Category	Handysize	Sub Panamax	Panamax	Post Panamax	Total
Bulk Carrier	1	30	55	-	**86**
Container	0	0	-	3	**3**
Cruise	-	-	-	-	**-**
Dry Cargo Barge	10	2	1	-	**13**
General Cargo	1	0	-	-	**1**
Reefer Cargo	-	-	-	-	**-**
RoRo Cargo	-	-	0	-	**0**
Tanker	12	127	23	-	**162**
Tanker Barge	4	-	-	-	**4**
Vehicle Carrier	0	-	-	-	**0**

The ocean going vessel fleet forecast assessment used the same forecast assumptions as the USACE National Economic Development (NED) Analysis for the Jacksonville Harbor Deepening Project. NED analysis includes fleet forecast for container vessels, dry cargo barge and general cargo vessels. The NED analysis does not include fleet forecast for other vessel types such as bulk carrier ships, vehicle carrier ship etc. USACE suggested to Taylor Engineering to assume a 0.5% yearly increase in vessel calls for all vessels except container vessels, dry cargo barge and general cargo ships. Taylor Engineering assumed that the harbor deepening project would begin in 2015 and end in 2020. Assuming a 50-year project life of the harbor deepening project, USACE developed a fleet forecast of the vessels arriving at JAXPORT terminals because of the harbor deepening from 2020 to 2070 at 10-year intervals. USACE assumed that the harbor deepening project would only affect the vessel traffic at JAXPORT terminals. Hence, the fleet forecast does not include any future growth for private terminals. USACE assumed that the Port of Jacksonville would reach capacity in 2040; hence the fleet forecasts from 2040 – 2070 does not change.

Table 4.5 USACE-Estimated Fleet Forecast at 10-Year Intervals from 2020 to 2070

Depth	**Number of Vessels**				
	Handy Size	**Sub Panamax**	**Panamax**	**Post Panamax**	**Total**
Year 2020					
40 feet (No Action Alternative)	608	1392	548	343	2890
44 feet	604	1392	502	271	2769
45 feet	604	1392	502	264	2762
47 feet (TSP)	604	1392	502	257	2755
48 feet	604	1392	502	254	2752
Year 2030					
40 feet (No Action Alternative)	614	1566	681	608	3468
44 feet	610	1566	544	500	3220
45 feet	610	1566	544	481	3201
47 feet (TSP)	610	1566	544	462	3182
48 feet	610	1566	544	458	3178
Years 2040-2070					
40 feet (No Action Alternative)	622	1744	773	847	3985
44 feet	618	1744	520	722	3603
45 feet	618	1744	520	691	3572

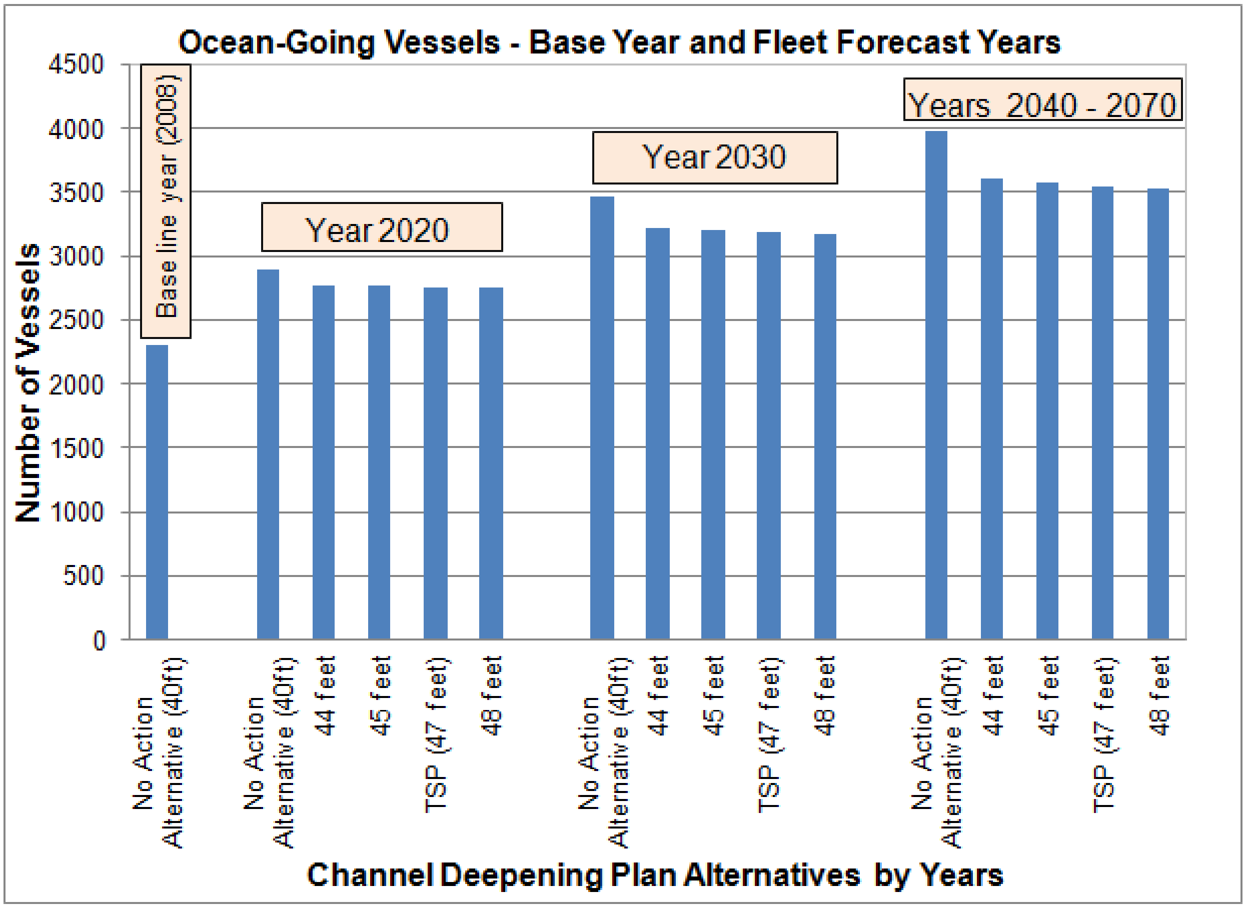
Depth	Number of Vessels				
	Handy Size	**Sub Panamax**	**Panamax**	**Post Panamax**	**Total**
Year 2020					
47 feet (TSP)	618	1744	520	657	3539
48 feet	618	1744	520	652	3533

This air emissions analysis used the USACE National Economic Development (NED) analysis fleet forecasts for every 10th year between 2020 and 2070 (inclusive) and for the following channel depths alternatives: -40 feet (No-Action), -44 feet, -45 feet, -46 feet, -47 feet, and -50 feet (MLLW) (Table 4.5). USACE identified the -45 feet channel depth alternative as the NED Plan for the Jacksonville Harbor deepening project. The non-Federal sponsor, JAXPORT, has requested -47 feet as the Locally Preferred Plan (LPP). The USACE has selected the LPP plan of -47 feet as the Tentatively Selected Plan for harbor deepening.

Figure 4.1 shows a plot of vessel calls for baseline year 2008 and future years 2020, 2030, 2040-2070 for No Action Alternative (existing 40 feet depth), 44 feet, 45 feet, 47 feet and 48 feet of harbor deepening depth alternatives. The number of vessel calls decreases as channel depth increases. The reason for decrease in vessel calls is due to an increase in load carried by post-panamax ships for deeper depths. A deeper channel would allow post-panamax ships to carry a higher load and thus fewer vessel calls would provide for the same or greater cargo traffic through the port. Additionally, JAXPORT's strategic plan predicts to see a substantial increase in vessel calls and loads for future years.

USACE predicts that the ocean-going vessel calls would increase by approximately 43% for the year 2040 from the baseline year of 2008.

Figure 4.1 Comparison of Ocean-Going Vessels for Baseline and Future Years



5.0 CALCULATIONS OF AIR EMISSIONS

Taylor Engineering compiled the best available information from nine sources to calculate the air emission loads for criteria pollutants within the Jacksonville Harbor. Table 5.1 lists the air emission sources and the name of agency/association that provided the data for the emission source.

Table 5.1 Sources of Air Emissions

Source of Emission	Data Provided by
Ocean-Going Vessels at JAXPORT Terminals and all private terminals	JAXPORT/USACE/St. Johns Bar Pilot Association/Jacksonville Marine Transportation Exchange (JMTX)
Tug Boats	Moran Towing and McAllister Towing
St. Johns River Ferry	JAXPORT/HMS Global Inc.
Annual Maintenance Dredging	USACE
Dredging Operation during	USACE

Source of Emission	Data Provided by
Harbor Deepening	
Cargo Handling Equipment at JAXPORT Terminals and all private terminals	JAXPORT/JMTX
Trucks entering JAXPORT Terminals and all private terminals	JAXPORT/JMTX
Fleet vehicles within JAXPORT Terminals and all private terminals	JAXPORT/JMTX
Locomotives operating within JAXPORT and all private terminals	JAXPORT

5.1 Harbor Fleet (Ocean-Going Vessels)

To obtain the cargo handling equipment, trucks, vehicles, and locomotive data used for years between 2008 and 2012, JAXPORT and JMTX contacted all the private terminals listed in Table 1.1 except for the U.S Marine Corps Command Center at Blount Island, which, for national security reasons, was not included in this analysis. Taylor Engineering compiled the available data provided by USACE, JAXPORT, JMTX, and private terminals for the baseline year of 2008. In cases when the data was unavailable for the year 2008, Taylor Engineering used annual data between 2009 and 2012 and assumed the data from that year would be similar to the year 2008. Ocean-Going Vessels

The Ocean fleet includes deep-draft ocean-going vessels that call at JAXPORT and private terminals within the Jacksonville Harbor. Emission calculations from ocean-going vessels require the number of ocean-going vessels in a given year, the modes of vessel operations, transit time, vessel engine power, and engine load factor and emission rates.

5.1.1 Transit Time

St. Johns Bar Pilot Association provided Taylor Engineering with information on the time required for ocean-going vessels to move within the harbor. The harbor pilots separated the typical transit time into three different modes of operation:

- Reduced Speed Zone/Full Maneuvering (10-12 knots)
- Slow/Dead Slow (6-8 knots), and
- Docking (2-5 knots)

Based on the operational criteria of the pilots, the pilots have divided the Jacksonville Harbor into the following four operational zones:

- Blount Island Terminals,

- TRAPAC/Dames Point Terminals,
- Trout River Terminals and
- Talleyrand Terminals

Taylor Engineering obtained average hoteling time of ships at these four terminals by analyzing the arrival and departure time of vessel data provided by JMTX for a six-month period in 2008. **Figure 5.1** shows the layout of the four operational zones within the Jacksonville Harbor. **Table 5.2** shows the average transit time taken by an ocean-going vessel to reach the four terminals. The table also shows a breakdown of different modes of operation for an ocean-going vessel traveling through the Jacksonville Harbor.

Figure 5.1 Operational Zones within Jacksonville Harbor

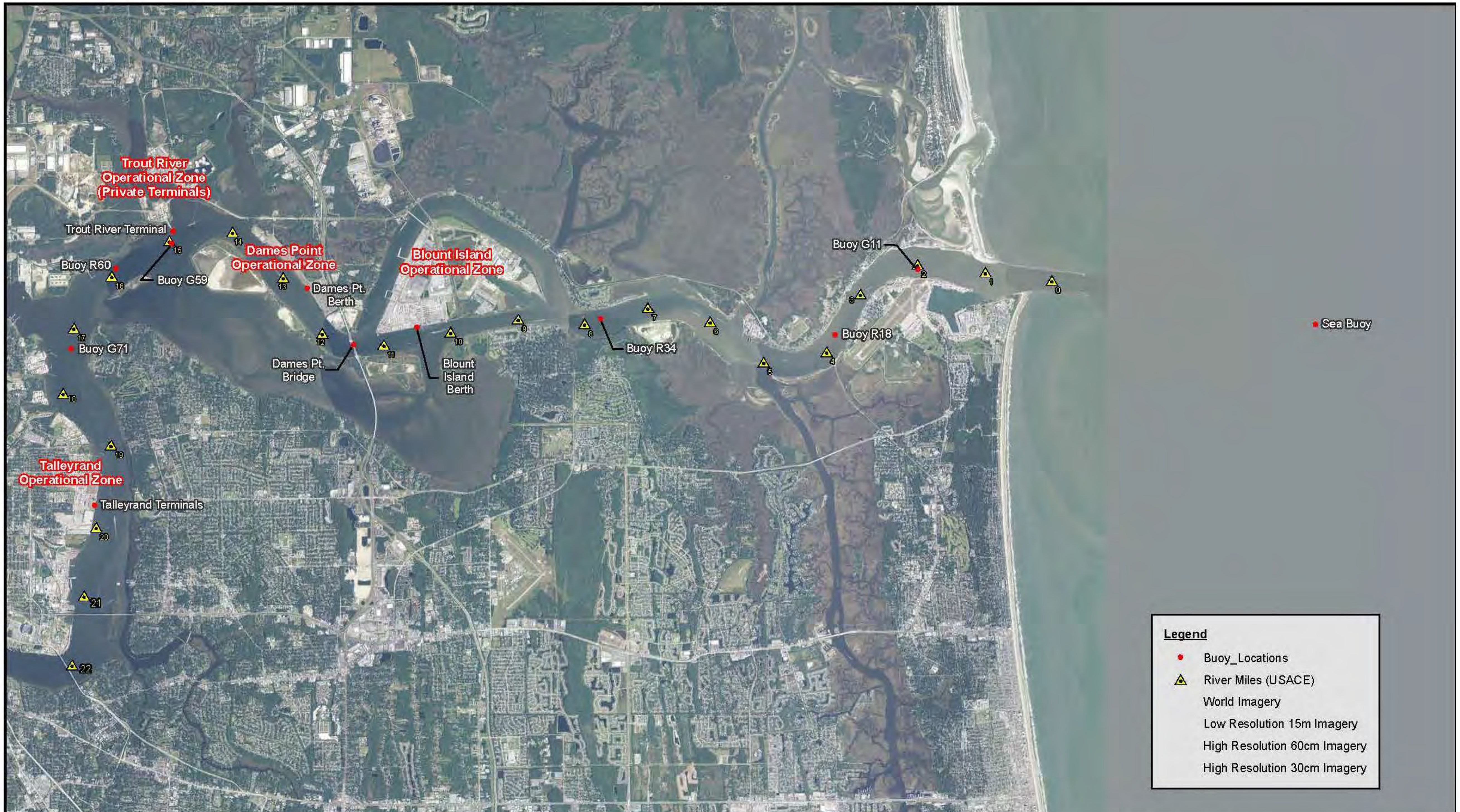


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FIGURE 5.1
Operational Zones within Jacksonville Harbor

Source Data:
1)Sea Buoys: Jacksonville Maritime Transportation Exchange
2)River Mile Markers: USACE
3)Imagery: USDA 2010

N

PROJECT	C2012-071
DATUM	NAD83, NAVD88
DRAWN BY	PL
DATE	MAY 2013

Table 5.2 Transit Time Data

Operation Mode	Speed (knots)	Operational Zone	From	To	Duration (hours)	Cumulative Duration (hours)
Reduced Speed Zone (RSZ)	10-12	Blount Island Terminals	Sea Buoy	Buoy G"11"	0.35	0.35
Maneuvering	6-8		Buoy G"11"	Buoy R"18"	0.25	0.6
Reduced Speed Zone (RSZ)	10-12		Buoy R"18"	Buoy R"34"	0.35	0.95
Docking	2-5		Buoy R"34"	Berth	0.5	1.45
Hotelling	0		At Berth		28	-
Reduced Speed Zone (RSZ)	10-12	Dames Point Terminals (TRAPAC)	Sea Buoy	Buoy G"11"	0.35	0.35
Maneuvering	6-8		Buoy G"11"	Buoy R"18"	0.25	0.6
Reduced Speed Zone (RSZ)	10-12		Buoy R"18"	Buoy R"34"	0.35	0.95
Maneuvering	6-8		Buoy R"34"	Dames Point Bridge	0.5	1.45
Docking	2-5		Dames Point Bridge	Berth	0.5	1.95
Hoteling	0		At Berth		26	-
Reduced Speed Zone (RSZ)	10-12	Trout River Terminals	Sea Buoy	Buoy G"11"	0.35	0.35
Maneuvering	6-8		Buoy G"11"	Buoy R"18"	0.25	0.6
Reduced Speed Zone	10-12		Buoy R"18"	Buoy R"34"	0.35	0.95

Operation Mode	Speed (knots)	Operational Zone	From	To	Duration (hours)	Cumulative Duration (hours)
(RSZ)						
Maneuvering	6-8		Buoy R"34"	Dames Point Bridge	0.5	1.45
Reduced Speed Zone (RSZ)	8-10		Dames Point Bridge	Buoy G"59"	0.4	1.85
Docking	2-5		Buoy G"59"	Berth	0.75	2.6
Hoteling			At Berth		28	-
Reduced Speed Zone (RSZ)	10-12	Talleyrand Terminals	Sea Buoy	Buoy G"11"	0.35	0.35
Maneuvering	6-8		Buoy G"11"	Buoy R"18"	0.25	0.6
Reduced Speed Zone (RSZ)	10-12		Buoy R"18"	Buoy R"34"	0.35	0.95
Maneuvering	6-8		Buoy R"34"	Dames Point Bridge	0.5	1.45
Reduced Speed Zone (RSZ)	8-10		Dames Point Bridge	Buoy R"60"	0.55	2
Maneuvering	6-8		Buoy R"60"	Buoy G"71"	0.3	2.3
Docking	2-5		Buoy G"71"	Berth	0.5	2.8
Hoteling	0		At Berth		30	-

5.1.2 Emission Calculations for Ocean-Going Vessels

Emission load calculations require classifying the existing vessel call data into appropriate vessel classes and vessel types. USACE, JAXPORT, and St. Johns Bar Pilot Association collected the call information for ocean-going vessels arriving at all terminals within the harbor for years 2008 – 2010. Based on the vessel's type and class, USACE classified the ocean-going vessel data into various vessel types and vessel classes (**Table 5.3**) arriving at various terminals within the harbor. For the baseline year of 2008, Taylor Engineering averaged one-way vessel calls of the ocean-going vessels from year 2008 to 2010 to account for changes in port operations and seasonality.

Table 5.3 One -Way Vessel Calls for Baseline Year (2008) Emissions At All Ports Within Jacksonville Harbor

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Bulk Carrier Ship	7	53	70	-
Container Ship	100	46	217	111
Cruise Ship	2	-	34	-
Dry Cargo Barge	158	87	271	-
General Cargo Ship	190	33	-	-
Reefer Cargo Ship	16	-	-	-
RO/RO Cargo Ship	27	15	162	-
Tanker	23	140	24	-
Tanker Barge	6	5	-	-
Vehicle Carrier Ship	23	480	8	-
Total	552	859	787	111

Because different ocean-going vessel types differ in the time each requires to reach the terminal areas, Taylor Engineering divided the vessel traffic into ships arriving at one of the four operational areas — Blount Island Terminals, Dames Point Terminals, Talleyrand Terminals, and Trout River Terminals. Out of these four operational areas, JAXPORT operates three operational areas — Blount Island Terminals, Dames Point Terminals, and Talleyrand Terminals (**Tables 5.4 – 5.6**). Taylor Engineering assumed vessel calls to all the private ports arrived at the Trout River Terminals (Table 5.7).

Table 5.4 One-way Vessel Calls for Baseline Year (2008) at Blount Island Terminals

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Bulk Carrier Ship	4	7	-	-
Container Ship	27	21	128	34
Cruise Ship	0	-	-	-
Dry Cargo Barge	141	2	98	-
General Cargo Ship	87	16	-	-
Reefer Cargo Ship	2	-	-	-
RoRo Cargo Ship	25	8	154	-
Tanker	1	1	0	-
Tanker Barge	2	5	-	-
Vehicle Carrier Ship	21	390	8	-
Total	310	450	388	34

Table 5.5 One-way Vessel Calls for Baseline Year (2008) at Dames Point Terminals

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Bulk Carrier Ship	0	14	14	-
Container Ship	-	0	11	65
Cruise Ship	2	-	34	-
Dry Cargo Barge	1	-	-	-
General Cargo Ship	-	-	-	-
Reefer Cargo Ship	-	-	-	-
RoRo Cargo Ship	-	-	0	-
Tanker	-	-	-	-
Tanker Barge	-	-	-	-
Vehicle Carrier Ship	0	6	-	-
Total	3	20	60	65

Table 5.6 One-way Vessel Calls for Baseline Year (2008) at Talleyrand Terminals

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Bulk Carrier Ship	2	2	1	-
Container Ship	73	24	78	9
Cruise Ship	0	-	-	-
Dry Cargo Barge	6	83	172	-
General Cargo Ship	102	16	-	-
Reefer Cargo Ship	14	-	-	-
RoRo Cargo Ship	1	7	8	-
Tanker	10	13	1	-
Tanker Barge	-	-	-	-
Vehicle Carrier Ship	1	85	-	-
Total	210	230	260	9

Table 5.7 One-way Vessel Calls for Baseline Year (2008) at Trout River Terminals (Private Terminals)

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Bulk Carrier Ship	1	30	55	-
Container Ship	0	0	-	3
Cruise Ship	-	-	-	-
Dry Cargo Barge	10	2	1	-
General Cargo Ship	1	0	-	-
Reefer Cargo Ship	-	-	-	-
RoRo Cargo Ship	-	-	0	-
Tanker	12	127	23	-
Tanker Barge	4	-	-	-
Vehicle Carrier Ship	0	-	-	-

Vessel Type	Vessel Class			
	Handy-size	Sub-Panamax	Panamax	Post-Panamax
Total	29	159	79	3

The emission load per vessel call was calculated based using the USEPA (2009) formula:

$$Emissions\ (E) = P\ x\ LF\ x\ T\ x\ ER$$

Where
E = Emissions per transit in grams/call
P = Engine Power in Kilowatts
T = Vessel Travel Time in Hours
ER = Emission rate from engine in (Grams/KW-hour)

Taylor Engineering obtained the typical engine sizes for various vessel types from USEPA (2009). **Table 5.8** provides the typical propulsion/main engine and auxiliary engine power by vessel types in kilowatts for the ships that use the Jacksonville Harbor

Table 5.8 Engine Power by Vessel Type

Vessel Type	Main/Propulsion Engine Power (KW)	Total Auxiliary Engine Power (KW)
Bulk Carrier	8,000	1,776
Container	30,900	6,800
Cruise	39,600	11,000
General Cargo	9,300	1,776
RO/RO	11,000	2,850
Reefer	9,600	3,900
Tanker	9,400	1,985
Tanker Barge	9,400	1,985
Vehicle/Automobile Carrier	10,700	2,850

Taylor Engineering consulted with St. Johns Bar Pilot Association to obtain the various vessel movements with similar vessel speed characteristics of all the vessels arriving into the Jacksonville Harbor (**Table 5.9**).

Table 5.9 Vessel Movements Characteristics within Jacksonville Harbor

Vessel Movement Type	Typical Average Speed (Knots)
Reduced Speed Zone (RSZ)/Full Maneuvering	8-12
Maneuvering / Slow / Dead Slow	5-8
Docking	2-5
Hoteling	0

USEPA requires using emission load factors to estimate emission loads based on vessel movement and vessel class types. For container ships, the emission load factors vary by the size of container vessels. USACE classified container vessels into handy-size, sub-panamax, panamax, and post-panamax vessel types. Table 5.10 provides the typical load factor values recommended by USEPA for main propulsion engine for each of these four vessel types and for various vessel movements. The typical load factors for auxiliary engines recommended by USEPA are similar for the four vessel types (Table 5.11).

Table 5.10 Main Propulsion Engine Load Factor for Container Ships

Type of Vessel Movement	Handy Size	Sub-Panamax	Panamax	Post-Panamax
Reduced Speed Zone	20%	16%	12%	10%
Maneuvering	5%	5%	3%	2%
Docking	5%	4%	3%	2%
Hoteling	0%	0%	0%	0%

Table 5.11 Auxiliary Engine Load Factor for Container Ships

Type of Vessel Movement	Load Factor for Handy Size, Sub-Panamax, Panamax, and Post Panamax
Reduced Speed Zone	25%
Maneuvering	48%
Docking	48%
Hoteling	19%

Taylor Engineering obtained the emission load factors for the main propulsion engines in ocean-going vessels other than container vessels (**Table 5.12**) from the USEPA-approved Savannah Harbor Expansion Project's (SHEP) Appendix K Air Quality Analysis (USACE, 2012).

Table 5.12 Main Propulsion Engine Load Factors for all Ocean-Going Vessels except Container Ships

Pollutant	Reduced Speed Zone (12% Low Load Factor)	Maneuvering (3% Low Load Factor)	Docking (3% Low Load Factor)	Hoteling (Main Engine Shutdown)
NO_x	1.14	2.92	2.92	0
CO	1.64	6.46	6.46	0
HC	1.76	11.68	11.68	0
PM10	1.24	4.33	4.33	0
PM2.5	1.2	4.2	4.2	0
SO_2	1.18	2.49	2.49	0
CO_2	1.17	2.44	2.44	0

For auxiliary engines on bulk, cruise, general cargo, roll-on/roll-off, reefer, tanker, tanker barges, and vehicle carrier ships, the USEPA (2009) based the load factors on the vessel class and movements of the vessel (**Table 5.13**).

Table 5.13 Auxiliary Engine Load Factors for All Ocean-Going Vessels except Container Ships

Vessel Type	Cruise	Reduced Speed Zone	Maneuver	Hoteling
Auto/Vehicle Carrier	0.15	0.3	0.45	0.25
Bulk Carrier	0.17	0.27	0.45	0.1
Cruise Ship	0.8	0.8	0.8	0.64
General Cargo	0.17	0.27	0.45	0.22
Miscellaneous	0.17	0.27	0.45	0.22
OG Tug	0.17	0.27	0.45	0.22
RORO	0.15	0.3	0.45	0.26
Reefer	0.2	0.34	0.67	0.32
Tanker	0.24	0.28	0.33	0.26

An emission rate is the rate at which a given engine discharges a particular pollutant. Taylor Engineering assumed that all ocean-going vessels coming into Jacksonville Harbor use Marine Diesel Oil (MDO) fuel for main propulsion and auxiliary engines and have Slow Speed Diesel (SSD) engines as their main propulsion engines (personal communication, Victoria Robas March 2013). **Table 5.14** provides the emission rates of main propulsion and auxiliary engines for various pollutants for all ocean-going vessels (USEPA 2009).

Table 5.14 Engine Emission Rate/Factors for MDO fuel (Grams/kW-Hour)

Engine Type	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Main Propulsion Engine	17.00	1.40	0.60	0.45	0.42	3.62	588.79
Auxiliary Engine	13.90	1.1	0.40	0.49	0.45	4.24	690.71

To calculate emission loads for the seven criteria pollutants, Taylor Engineering used the engine power, load factor, travel time, and emission rates of each type of ocean going vessel arriving within the Jacksonville Harbor Emission loading calculation for operation of the main propulsion engine and auxiliary engine involves calculating emission loads separately for each type of vessel movement:

- Reduced Speed
- Maneuvering
- Docking
- Hoteling

Taylor Engineering calculated emission loads from vessel main engine operations necessary to travel to each harbor operational zone in reduced speed, maneuvering and docking movements (**Table 5.15**), from auxiliary engine operations for the same purposes (**Table 5.16**) and from hoteling vessel operation (operation of auxiliary engines while ships are stationary at a dock) (**Table 5.17**).

Table 5.15 Emission Load from Main Propulsion Engine for each container vessel arriving at JAXPORT's Blount Island Terminal (tons per call)

Vessel Class	Emission Load (tons/vessel call)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Handy Size	0.0517	0.0059	0.0031	0.0015	0.0014	0.0011	1.7687
Sub-Panamax	0.0741	0.0096	0.0054	0.0023	0.0021	0.0015	2.4924
Panamax	0.1012	0.0146	0.0077	0.0041	0.0037	0.0021	3.3254
Post-Panamax	0.1634	0.0247	0.0179	0.0058	0.0052	0.0031	4.9533

Table 5.16 Emission Load from Auxiliary Engine for each container vessel arriving at JAXPORT's Blount Island Terminal (tons per call)

Vessel Class	Emission Load (tons/vessel call)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Handy Size	0.0241	0.0019	0.0007	0.0009	0.0008	0.0007	1.1995
Sub-Panamax	0.0381	0.0030	0.0011	0.0013	0.0012	0.0011	1.8911
Panamax	0.0613	0.0048	0.0018	0.0022	0.0020	0.0019	3.0452
Post-Panamax	0.1009	0.0080	0.0029	0.0036	0.0033	0.0030	5.0119

Table 5.17 Emission Load from Hoteling for each container vessel arriving at JAXPORT's Blount Island Terminal (tons per call)

Vessel Class	Emission Load (tons/vessel call)

	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Handy Size	0.2400	0.0190	0.0069	0.0085	0.0078	0.0073	11.9275
Sub-Panamax	0.3784	0.0299	0.0109	0.0133	0.0123	0.0114	18.8050
Panamax	0.6094	0.0482	0.0175	0.0215	0.0197	0.0184	30.2816
Post-Panamax	1.0029	0.0794	0.0289	0.0354	0.0325	0.0303	49.8378

Table 5.18 shows the emission load from one container vessel traveling to an operational area that includes the sum of emission loads for each pollutant from Tables 5.15 – 5.17.

Table 5.18 Emission Load for one Container Vessel at JAXPORT's Blount Island Terminal (Tons/vessel)

Vessel Class	Emission Load (tons/vessel call)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Handy Size	0.3918	0.0345	0.0145	0.0132	0.0121	0.0109	17.8638
Sub-Panamax	0.6027	0.0551	0.0239	0.0206	0.0189	0.0168	27.5721
Panamax	0.9344	0.0872	0.0364	0.0339	0.0311	0.0262	43.0230
Post-Panamax	1.5314	0.1447	0.0705	0.0541	0.0495	0.0425	69.7682

Taylor Engineering used the number of container vessels arriving at Blount Island Terminal for the baseline year (**Table 5.4**) to calculate the total emission load by multiplying emission loads of each pollutant from **Table 5.18** by the total number of container ships arriving and departing (round trip transit) Blount Island Terminals for the baseline year (**Table 5.19**). Similar calculations were made for the other operational areas (Table 5.19).

Table 5.19 Emission Loads for All Container Vessels at JAXPORT's Blount Island Terminal the Baseline Year 2008

	Emissions (Tons / Year)			
Pollutant	Blount Island	Dames Point	Talleyrand	Private Terminals
NO_x	195.31	119.18	178.49	5.67
CO	18.21	12.26	17.46	0.57
HC	7.97	6.3	7.95	0.31
PM10	6.99	4.27	6.34	0.2

PM2.5	6.39	3.9	5.79	0.18
SO_2	55.11	32.48	48.73	1.53
CO_2	8958.5	5274.85	7913.66	248.02

As stated previously, Taylor Engineering considered all ocean-going vessels arriving at all private terminals within the harbor under the Trout River Terminals operational zone. Trout River Terminal is located centrally within the 25-mile long Jacksonville Harbor. Because private ports are dispersed within the harbor, using Trout River Terminal as the central location would provide reasonable estimate of average travel time taken by ocean-going vessels to travel to the private ports.

Emission load calculations for all ocean-going vessels except container vessels are based on the type of pollutant and movements of the vessel. Taylor Engineering calculated the emission load of the main propulsion and auxiliary engines for bulk carrier, cruise ship, dry cargo, general cargo, reefer cargo, RoRo cargo, tanker, tanker barge, and auto carrier ships arriving at the four operational zones within Jacksonville Harbor during the reduced speed zone, maneuvering, docking, and hoteling modes of operations.

The emission load calculations involve use of engine power, load factor, travel time, and emission rate for main and auxiliary engines. Table 5.8 provided engine power, Tables 5.12 and 5.13 provided engine load factors, Table 5.2 provided travel time to various operational zones within the harbor, and Table 5.14 provided the emission rate for various criteria pollutants from the main propulsion and auxiliary engines for all vessel types except container vessels. Taylor Engineering used the information from these tables to estimate the emission loads for each vessel type arriving at Blount Island Terminal, Dames Point Terminal, Talleyrand Terminal, and Trout River Terminal. Tables 5.4 – 5.7 provided the total number of vessels arriving at the four terminals for the year 2008. Taylor Engineering multiplied the total number of vessels and the emission load for each vessel (Table 5.20 – Table 5.23) to obtain the total emission load for vessels for each category.

Table 5.20 Emission Load from One Bulk Carrier Vessel Arriving at Blount Island Terminal during Reduced Speed Zone Mode of Operation (tons/transit)

Engine Type	Emission Load from one Bulk Vessel (Tons/transit)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Main Propulsion Engine	0.171	0.020	0.009	0.005	0.004	0.038	6.075
Auxiliary Engine	0.007	0.001	0.000	0.000	0.000	0.002	0.365
Total	0.178	0.021	0.010	0.005	0.005	0.040	6.440

Table 5.21 Emission Load from One Bulk Carrier Vessel Arriving at Blount Island Terminal during Maneuvering Mode of Operation (tons/transit)

Engine Type	Emission Load from one Bulk Vessel (Tons/transit)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Main Propulsion Engine	0.438	0.080	0.062	0.017	0.016	0.079	12.669
Auxiliary Engine	0.012	0.001	0.000	0.000	0.000	0.004	0.608
Total	0.450	0.081	0.062	0.018	0.016	0.083	13.278

Table 5.22 Emission Load from One Bulk Carrier Vessel Arriving at Blount Island Terminal during Docking Mode of Operation (tons/transit)

Engine Type	Emission Load from one Bulk Vessel (Tons/transit)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Main Propulsion Engine	0.438	0.080	0.062	0.017	0.016	0.079	12.669
Auxiliary Engine	0.012	0.001	0.000	0.000	0.000	0.004	0.608
Total	0.450	0.081	0.062	0.018	0.016	0.083	13.278

Table 5.23 Emission Load from One Bulk Carrier Vessel Arriving at Blount Island Terminal during Hoteling Mode of Operation (tons/transit)

Engine Type	Emission Load from one Bulk Vessel (Tons/transit)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Auxiliary Engine	0.003	0.000	0.000	0.000	0.000	0.001	0.135

Using the total number of bulk carrier vessels arriving at Jacksonville Harbor's several terminals (Tables 5.4 – 5.7), Taylor Engineering calculated the total emission load for bulk carrier vessels calls to the Harbor for the year 2008 (Table 5.24) as the product of the discharge per ship by times the number of each type ship calling in the baseline year (Tables 5.3 – 5.7).

Table 5.24 Emission Loads from All Bulk Carrier Vessels Arriving at Jacksonville Harbor terminals for the baseline year (tons/year)

Pollutant	Discharge (Tons / Year)			
	Blount Island	Dames Point	Talleyrand	Private Terminals
NO_x	11.01	40.47	9.61	156.38
CO	1.72	6.62	1.54	25.29
HC	1.2	4.78	1.09	18.03
PM10	0.4	1.51	0.35	5.76
PM2.5	0.36	1.36	0.32	5.22

Pollutant	Discharge (Tons / Year)			
	Blount Island	Dames Point	Talleyrand	Private Terminals
SO_2	2.24	7.99	1.91	31.02
CO_2	359.9	1280.32	306.59	4969.67

Similar to the methodology used to obtain emission loads from bulk carrier vessel ships, Taylor Engineering calculated emission loads for the following vessel types for the baseline year (**Table 5.25**):

- Cruise Ship
- Dry Cargo Barge Ship
- General Cargo Ship
- Reefer Cargo Ship
- Roll on Roll off (RoRo) Cargo Ship
- Tanker
- Tanker Barge
- Automobile/Vehicle Carrier Ship

Table 5.25 Emission Load from Ocean-Going Vessels except Container Ships for the Baseline Year

Operational Zone	Vessel Type	Emission Load for all vessels in year 2008 (Tons/year)						
		NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
JAXPORT's Blount Island Terminal	Cruise Ship	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dry Cargo Barge	298.30	45.20	30.98	10.82	9.82	62.61	10057.43
	General Cargo	128.73	19.51	13.37	4.67	4.24	27.02	4340.14
	Reefer Cargo	3.40	0.45	0.29	0.12	0.11	0.79	128.03
	RoRo Cargo	300.34	43.69	29.31	10.87	9.87	65.43	10527.49
	Tanker	2.60	0.39	0.26	0.09	0.09	0.56	89.33
	Tanker Barge	9.11	1.35	0.92	0.33	0.30	1.94	312.66
	Vehicle Carrier	655.30	95.06	63.67	23.71	21.53	143.12	23030.64
JAXPORT's Dames Point Terminal	Cruise Ship	357.55	50.07	33.31	13.11	11.92	81.38	13117.39
	Dry Cargo Barge	1.75	0.28	0.20	0.06	0.06	0.35	56.47
	General Cargo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reefer	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Operational Zone	Vessel Type	Emission Load for all vessels in year 2008 (Tons/year)						
		NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
	Cargo							
	RoRo Cargo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Tanker	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Tanker Barge	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vehicle Carrier	12.88	2.00	1.41	0.48	0.43	2.68	430.55
JAXPORT's Talleyrand Terminal	Cruise Ship	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dry Cargo Barge	605.26	95.61	67.22	22.15	20.08	122.59	19659.17
	General Cargo	272.60	43.06	30.27	9.98	9.04	55.21	8854.13
	Reefer Cargo	40.46	5.83	3.91	1.47	1.34	8.92	1435.71
	RoRo Cargo	46.20	7.10	4.93	1.69	1.53	9.61	1543.43
	Tanker	57.27	8.95	6.26	2.09	1.90	11.72	1881.23
	Tanker Barge	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vehicle Carrier	242.58	37.22	25.79	8.86	8.04	50.57	8120.29
Trout River Terminal	Cruise Ship	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dry Cargo Barge	28.40	4.52	3.19	1.04	0.95	5.73	918.82
	General Cargo	2.18	0.35	0.25	0.08	0.07	0.44	70.68
	Reefer Cargo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	RoRo Cargo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Tanker	365.33	57.49	40.45	13.42	12.17	74.52	11954.28
	Tanker Barge	9.02	1.42	1.00	0.33	0.30	1.84	295.17
	Vehicle Carrier	0.00	0.00	0.00	0.00	0.00	0.00	0.00

USACE provided Taylor Engineering with forecast data for JAXPORT’s Blount Island Terminal, Dames Point Terminal, and Talleyrand Terminals for each vessel type for years 2020, 2030, 2040-2070. Taylor Engineering used methodologies similar to the

2008 emission load calculations to calculate emission loads from each vessel type for these forecast years and for each dredging depth (44 feet, 45 feet, 47 feet, and 48 feet). Because the USACE's National Economic Development (NED) analysis assumes zero growth in vessel traffic arriving at all private terminals within Jacksonville Harbor after the harbor deepening. Taylor Engineering used the 2008 emission loads from vessels arriving at all private terminals (Trout River Terminals) for the years of 2020, 2030, 2040 and 2070.

Taylor Engineering summed the emission loads from each vessel category arriving at the four terminals to obtain the total emission loads. Table 5.26 shows the total emission loads for all ocean going vessels arriving at all terminals within the Jacksonville Harbor for the year 2008, 2020, 2030, and 2040 – 2070. Attachment B includes a detailed set of emission calculations.

Table 5.26 Total Emission Loads for All Ocean-Going Vessels Arriving at Jacksonville Harbor

Depth	Emission Load (Tons/year)						
	NOx	**CO**	**HC**	**PM10**	**PM2.5**	**SO2**	**CO2**
Year 2008							
40 feet	4,155.36	603.22	404.62	151.17	137.32	908.06	146,134.54
Year 2020							
40 feet (No Action Alternative	2,787.18	654.75	428.39	170.20	154.74	106.71	170,970.94
44 feet	2,694.36	638.57	420.22	164.56	149.58	102.43	163,956.90
45 feet	2,687.73	637.45	419.66	164.16	149.21	102.12	163,450.13
47 feet (TSP)	2,680.82	636.27	419.05	163.74	148.83	101.80	162,926.54
48 feet	2,678.31	635.87	418.86	163.59	148.69	101.68	162,731.52
Year 2030							
40 feet (No Action Alternative	1,726.28	747.84	480.53	199.70	181.67	127.81	205,442.17
44 feet	1,632.80	717.17	465.78	188.70	171.61	119.42	191,692.47
45 feet	1,623.52	714.13	464.23	187.62	170.62	118.58	190,326.82
47 feet (TSP)	1,614.65	711.19	462.72	186.58	169.67	117.79	189,026.96
48 feet	1,612.61	710.54	462.40	186.34	169.45	117.60	188,721.61
Years 2040 - 2070							
40 feet (No Action Alternative	1,954.72	832.86	528.80	226.29	205.94	146.71	236,313.71
44 feet	1,815.47	787.67	507.67	209.88	190.93	134.19	215,802.40
45 feet	1,800.27	782.67	505.11	208.10	189.30	132.83	213,568.40
47 feet (TSP)	1,783.67	777.17	502.29	206.16	187.52	131.34	211,136.77

Depth	Emission Load (Tons/year)						
	NOx	CO	HC	PM10	PM2.5	SO2	CO2
48 feet	1,781.23	776.39	501.90	205.87	187.26	131.12	210,771.62

5.2 Intra Harbor Shifts

Intra harbor shift involves movement of ocean-going vessels from one terminal to another terminal within the harbor. JMTX and St. Johns Bar Pilot Association indicated that for the year 2008 185 shifts occurred (Table 5.27). The average movement times for different modes of operations during vessel shifts (Table 5.28) was found independent of vessel type.

Table 5.27 Number of Vessel Shifts within Jacksonville Harbor for baseline year 2008

Bulk	Breakbulk	Container	Tanker	Reefer	RO/RO	Total
20	17	24	112	3	9	**185**

Table 5.28 Average Time to Shift Vessels within Jacksonville Harbor (minutes)

Un-Docking	Maneuvering	Docking
30 min	45 min	30 min

Taylor Engineering calculated the emission load from all intra-harbor shifts within Jacksonville Harbor for the baseline year (**Table 5.29)** using the engine power, load factor and emission rates of vessels obtained from section 5.1**.** Assuming the baseline year's percentage of vessel shifts (8% of total vessel calls); Taylor Engineering obtained the number of vessel shifts for future years by calculating 8% of the total vessel calls from fleet forecast for future years. Table 5.29 shows the emissions from vessel shifts for all years 2020, 2030, and 2040 – 2070 for all depth alternatives. Attachment B contains the detailed emission load calculations for all years and depth alternatives.

Table 5.29 Total Emission Load from Vessels during Intra Harbor Shifts

Depth	Emission Load (Tons/year)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Year 2008							
40 feet	251.15	44.89	34.51	9.82	8.90	46.64	7442.72
Year 2020							
40 feet (No Action Alternative	186.93	56.22	43.25	12.28	11.13	5.78	9,282.62
44 feet	178.87	53.79	41.39	11.75	10.65	5.54	8,882.51
45 feet	178.06	53.55	41.20	11.70	10.60	5.51	8,842.50
47 feet (TSP)	178.06	53.55	41.20	11.70	10.60	5.51	8,842.50

Depth	Emission Load (Tons/year)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
48 feet	177.26	53.31	41.01	11.65	10.55	5.49	8,802.49
Year 2030							
40 feet (No Action Alternative	119.55	67.36	51.83	14.72	13.33	6.93	11,123.14
44 feet	110.95	62.52	48.10	13.66	12.37	6.43	10,322.92
45 feet	110.09	62.03	47.73	13.56	12.28	6.38	10,242.90
47 feet (TSP)	109.66	61.79	47.54	13.50	12.23	6.36	10,202.88
48 feet	109.66	61.79	47.54	13.50	12.23	6.36	10,202.88
Years 2040 – 2070							
40 feet (No Action Alternative	137.18	77.30	59.47	16.89	15.30	7.95	12,763.61
44 feet	124.28	70.03	53.88	15.30	13.86	7.21	11,563.27
45 feet	122.99	69.30	53.32	15.14	13.72	7.13	11,443.24
47 feet (TSP)	122.13	68.82	52.95	15.04	13.62	7.08	11,363.21
48 feet	121.70	68.57	52.76	14.98	13.57	7.06	11,323.20

5.3 Tugs

Tugs are used to assist ocean-going vessels navigate through the harbor, dock and undock vessels, and move the vessels between terminals within the harbor. The two primary tug operators in Jacksonville Harbor – McAllister Towing and Moran Towing – provided Taylor Engineering with information on the engine characteristics of tugs, operational requirements, and average hours of use for all the tugs within the harbor. **Table 5.30** shows the engine characteristics of all the tugs currently operational within the Jacksonville Harbor. All the engines on the tugboats are Category 2 engines (USEPA 2009).

Table 5.30 Engine Characteristics of Tugs

Tug Operator	Tug Boat	Main Engine Power (HP)	Number of Auxiliary Engines	Auxiliary Engine Power	USEPA's Engine Tier
McAllister Towing	2	4000	2	45	0
	1	3200	2	45	0
	1	2400	2	45	0
Moran Towing	1	3200	2	45	0
	3	3000	2	45	0

McAllister Towing and Moran Towing also provided the number of tugs and average tug engine time required to move an ocean-going vessel within the harbor. The towing companies used four tugs for each ocean-going vessel and 2.2 hours of engine operating time per tug to move the ocean-going vessel from the harbor entrance until docking the vessel at a terminal. Taylor Engineering assumed that all eight tugs are used to dock/undock and shift vessels equally throughout the year. USEPA (2009) provided the following formula to calculate emission load from tugs -

$$Emissions_{pollutant,H/C} = N_{H/C} \times \{(EF_{pollutant,H/C,main} \times N\ Eng_{H/C,main} \times LF_{H/C.main} \times Activity_{HC,main} \times HP_{H/C,main}) + (EF_{pollutant,H/C,aux} \times N\ Eng_{H/C,aux} \times LF_{H/C,aux} \times Activity_{H/C,aux} \times HP_{H/C,aux})\}$$

Where,

H/C – Harbor Craft
$Emissions_{pollutant,H/C}$ – Emission load in grams/year for each pollutant from all harbor craft vessels/tugs
$N_{H/C}$ – Number of **H**arbor **C**raft Vessels/Tugs
$EF_{pollutant,H/C,main}$ and $EF_{pollutant,H/C,aux}$ – Emission Factor of a pollutant from main engine and auxiliary engine
$N\ Eng_{H/C,main}$ and $N\ Eng_{H/C,aux}$ – Number of main and auxiliary engines
$LF_{H/C.main}$ and $LF_{H/C,aux}$ – Load Factor of Main and Auxiliary engine
$Activity_{HC,main}$ and $Activity_{H/C,aux}$ – Activity performed by main and auxiliary engine (hours)
$HP_{H/C,main}$ and $HP_{H/C,aux}$ – Engine Power of Main and Auxiliary engine (KW)

Engine emission factors for the main and auxiliary tugboat engines (**Table 5.31**) were obtained from USEPA (2009: Table 3-8). Because all the tugboat engines use ULSD (Ultra Low Sulfur Diesel) engines, the engine emission factors shown in Table 5.37 are adjusted to obtain factors for the ULSD fuel (USEPA, 2009).

Table 5.31 Engine Emission Factors for Tugs from USEPA (2009: Table 3-8)

Pollutant	Main Engine Emission factor (g/KW-hr)	Auxiliary Engine Emission factor (g/KW-hr)
NO_x	13.2	13.2
CO	1.1	1.1
VOC	0.5	0.5
PM 10	0.62	0.62
PM 2.5	0.6	0.6
SO_2	0.01	0.01
CO_2	690	690

Taylor Engineering used the data from **Table 5.30, Table 5.31** and the tugboat operation time provided by the towing companies (above) to calculate the total emission load from each tug to move one ocean-going vessel from the SJB to a dock (**Table**

5.32). Tugboat operators estimated that moving a ship from SJB to any of the docks within the project deepening area averaged 2.2 hours

Table 5.32 Emission Load of Each Tugboat operating in Jacksonville Harbor for Moving one Ocean-Going Vessel within the Jacksonville Harbor (tons/vessel)

Tug Engine Size	Emission Load (Tons/vessel)						
	NO_x	CO	HC	PM10	PM 2.5	SO_2	CO_2
4000	0.1647	0.0137	0.0062	0.0077	0.0075	0.0001	8.6107
3200	0.1323	0.0110	0.0050	0.0062	0.0060	0.0001	6.9137
3000	0.1862	0.0155	0.0070	0.0087	0.0085	0.0001	9.7342
2400	0.0499	0.0042	0.0019	0.0023	0.0023	0.0000	2.6084
Total	0.5331	0.0444	0.0201	0.0250	0.0243	0.0003	27.8671

Using the total number of vessels arriving at the Jacksonville Harbor for the baseline year of 2008, Taylor Engineering calculated the emission load from all eight tugs by multiplying the total emission load for each pollutant with the total of vessels (Table 5.33).

Table 5.33 Total Emission Load from All Tugboat Activity for Baseline Year 2008

No. of Vessels	Emission Load by Tugs (tons/year)						
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2,309	1,230.95	102.58	46.39	57.74	56.01	0.61	64,345.03

Assuming the operational requirements for tugs would not change in future; Taylor Engineering used the fleet forecast data of ocean-going vessels to calculate the emission loads from tugs for years 2020, 2030, and 2040 – 2070. Attachment B shows the detailed calculation of emissions from tugs for all these years for all depth alternatives.

During ocean going vessel shifts within the harbor, tugs are used to undock, maneuver and dock ocean-going vessels. Taylor Engineering assumed that a tug on an average spends about 30 minutes to shift an ocean-going vessel. JMTX provided the number of vessel shifts within the harbor for the baseline year of 2008. JMTX's data indicate that about 8% of ocean-going vessels arriving at ports within Jacksonville harbor in the year 2008 shifted from one dock to another within the harbor.

Taylor Engineering calculated the emission load from all eight tugs operating during ocean-going vessels intra-harbor shifts within Jacksonville Harbor for the baseline year (**Table 5.34)** using the engine power, load factor, time spent and emission rates of tugs**.**

Table 5.34 Total Emission Load from All Tugboat Activity during vessel shifts, Baseline Year (2008)

No. of vessel shifts	Emission Load by Tugs (tons/year)						
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
185	22.41	1.87	0.84	1.05	1.02	0.01	1,171.68

Assuming the baseline year's percentage of vessel shifts (8% of total vessel calls), Taylor Engineering obtained the vessel shifts for future years by calculating 8% of the fleet forecast for future years. Attachment B shows the detailed calculation of emissions from tugs during shift for all years 2020, 2030, and 2040 – 2070 for all depth alternatives.

5.4 Maintenance Dredging

The USACE Jacksonville District performs yearly maintenance dredging of the federal channel to maintain the federally mandated water depth of 40 feet. The terminal operators are responsible for maintaining depths at their terminal berths. The berth maintenance operations are of a small scale compared to those required for maintaining the federal channel. This study does not consider the air emissions, which are likely negligible, from the dredging carried out by terminal operators.

The USACE provided Taylor Engineering with records of maintenance dredging carried out from 2007 – 2011. After reviewing the maintenance dredging data, Taylor Engineering identified the typical dredge and supporting equipment used for maintenance dredging in a given year and average yearly hours of operation as shown in Table 5.35.

Table 5.35 Dredging Equipment Used In Maintenance Dredging for Baseline Year 2008

Equipment Type	Total Number of Equipment	Average Engine Size (HP)	Days of use	Hours of use	Engine Load Factor
Hopper Dredge	2	12500	46	1,095	0.69
Pipeline Dredge	1	2400	94	2,256	0.69
Mechanical Dredge	1	2500	30	720	0.69
Survey Boat	1	300	170	4,071	0.31
Crew Boat	1	1000	170	4,071	0.45

Taylor Engineering obtained engine load factor and emission rates for all the equipment used for maintenance dredging from USACE Savannah Harbor Expansion Project's Air Quality Analysis (USACE, 2012) and EPA report (USEPA, 2009)..Taylor Engineering calculated the emission load from each piece of equipment used for the baseline year (Table 5.36) using the USEPA formula for calculating emissions from vessels and equipment (USEPA, 2009).

Assuming that the annual dredging requirement for future years would remain similar to the baseline year maintenance dredging, Taylor Engineering used the annual dredging emissions from Table 5.42 for years 2030 and 2040 – 2070.

Table 5.36 Total Emission Load from Equipment Used In Maintenance Dredging for Baseline Year 2008

Equipment	Pollutant Emission Load from Maintenance Dredging (Tons/year)						
	NO_x	CO	HC	PM10	PM 2.5	SO_2	CO_2
Hopper Dredge	207.43	38.51	1.54	4.97	4.50	60.86	10,713.24
Pipeline Dredge	40.54	3.38	1.53	1.90	1.84	0.02	2,118.93
Mechanical Dredge	13.48	1.12	0.51	0.63	0.61	0.01	704.43
Survey Boat	3.11	0.47	0.08	0.08	0.08	0.00	214.73
Crew Boat	19.58	3.76	0.40	0.39	0.38	0.01	1,039.04
Total Emissions	**284.13**	**47.24**	**4.07**	**7.97**	**7.42**	**60.90**	**14,790.37**

5.5 Dredging During Harbor Deepening

As stated in Section 2.0, the objective of the GRR II is to identify a suitable depth and dimensions for dredging a channel in the St. Johns River to allow for a safe passage for post-panamax vessels. USACE identified the -45 feet channel depth alternative as the NED Plan for the Jacksonville Harbor deepening project. The non-Federal sponsor, JAXPORT, has requested -47 feet as the Locally Preferred Plan (LPP). The USACE has selected the LPP plan of -47 feet as the Tentatively Selected Plan for harbor deepening.

USACE assumes the equipment listed in **Table 5.37** would be used to construct all the plans and provides USACE's estimated duration of equipment use for water depths of 44, 45, and 47 feet.

Table 5.37 Dredging Equipment requirements for Harbor Deepening (personal communication Michael Hollingsworth, USACE March 2013)

Equipment	Engine Horse Power (HP)	Engine Horse Power (KW)	Total Hours of use from years 2015-2020 for various depths (hours)			
			44ft	45ft	47ft	48ft
26 CY Clamshell Dredge	5000	3728	21,624	21,456	21,672	21,720
Work Tug Boat	250	186	100,032	110,280	133,728	147,428
Crew/Survey Boat	100	75	200,064	220,560	267,456	294,856
Derrick	200	149	200,064	220,560	265,296	292,475
Towing Vessel	3000	2237	100,032	110,280	133,728	147,428
Hydraulic Excavator (Dredge)	2734	2039	78,408	88,824	112,056	126,942

Taylor Engineering obtained engine load factors and emission rates for all the equipment used to dredge the Jacksonville Harbor from USACE Savannah Harbor Expansion Project's Air Quality Analysis (USACE, 2012) and EPA report (USEPA 2009).

Taylor Engineering calculated the emission load from each piece of equipment used for the baseline year (Table 5.38) using the USEPA formula for calculating emissions from vessels and equipment (USEPA, 2009).

Table 5.38 Total Emission Load from all Equipment Used in Dredging the Jacksonville Harbor for year 2020

	Emission Load (tons/year)						
Dredging Depth	**NO_X**	**CO**	**HC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
44ft	733.02	64.30	27.11	33.37	32.37	0.37	39,124.39
45ft	800.03	70.22	29.58	36.41	35.31	0.40	42,709.87
47ft	955.17	83.88	35.30	43.45	42.15	0.48	51,004.94
48ft	1,050.70	92.28	38.83	47.79	46.36	0.53	56,109.02

USACE estimated dredging the St. Johns River for the harbor deepening project would take about 5 years, starting in 2015 and ending in 2019. Because a detailed dredging schedule is currently unavailable, Taylor Engineering assumed that the total emission load resulting from the dredging of the harbor would be uniformly spread over a five years period. For first year of post-construction operation (year 2020), Taylor Engineering used an average yearly emission load obtained by dividing the total pollutant emission load by five years shown in Table 5.38.

During dredging, the contractor would use several pieces of support equipment to assist the major dredging equipment during the dredging process. Taylor Engineering assumed the emission load from the support equipment would be negligible and would not significantly affect the total emission loads shown in Table 5.38.

5.6 St. Johns River Ferry

The St. Johns River Ferry is a car and passenger ferry service that connects the north and south ends of Florida State Road A1A in Duval County to Mayport Village across the St. Johns River. Prior to 2012, JAXPORT operated the ferry service. Currently, the City of Jacksonville and its contractor HMS Global Maritime operate the ferry service.

The ferry makes 53 one-way trips during weekdays and for 52 one-way trips during weekends covering a one-way distance of 0.5 miles across the St. Johns River. The ferry requires about 8 minutes per one-way crossing the St. Johns River. **Table 5.39** shows the characteristics of the ferryboat engine provided by HMS Global Maritime and JAXPORT.

Table 5.39 Vessel Characteristics of St. Johns River Ferry

Vessel Name	Vessel Make Year	Main Engine Power (HP)	Auxiliary Engine Power (HP)	Type of Fuel Used
Jean Ribault	1996	1950	87	Diesel

Taylor Engineering assumed an average main engine load factor of 85 percent and an average auxiliary load factor of 56 percent, similar to the harbor vessel load factors stated in USEPA, (2009: Table 3.3). USEPA (2009: Table 3.8) provided the emission rates for the ferry. Using the vessel's engine characteristics and operational schedule, load factors, and emission rates, Taylor Engineering calculated the yearly pollutant emission load from the ferry operations (Table 5.40).

Table 5.40 Total Emission load from St. Johns Ferry Service (tons/year)

NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
95.87	7.99	3.61	4.50	4.36	0.05	5011.24

Taylor Engineering assumed that the ferry emission load (Table 5.40) would remain constant for future years (years 2020, 2030, 2040-2070).

5.7 Projected Growth Rate for Landside Emissions

To estimate emissions from landside for future years, it is necessary to project the growth rate for cargo handling equipment, cargo truck, fleet vehicles, and locomotives. JAXPORT expects the use of landside emission sources to grow proportionally to the growth in ocean going container vessel traffic for future years. Based on fleet forecast for container vessels, Taylor Engineering estimated an average annual growth of 3.4% in the container vessels from years 2020 to 2040. Taylor Engineering assumed an average annual growth rate of 0.5% in container vessels from baseline year of 2008 to 2020. Table 5.41 shows the growth rate in landside equipment from year 2008 to 2040.

Table 5.41 Projected Growth Rate for future years

Year	Projected Growth Rate
2008	-
2020	4%
2030	34%
2040	68%

For future years, Taylor Engineering used the projected growth percentage to increase the hours of use for cargo handling equipment, cargo truck, fleet vehicles and locomotives.

5.8 Cargo Handling Equipment

JAXPORT and JMTX contacted all the terminals to obtain detailed information on the Cargo Handling Equipment (CHE) used in terminals within the Jacksonville Harbor. The cargo handling equipment included container cranes, rubber tire gantry cranes, top lifts, empty container handlers, jockey trucks and other cargo handling equipment. The information obtained includes equipment type, number of equipment, and amount of use (**Table 5.42**). Container cranes at JAXPORT's Dames Point Terminal are electric and some of the diesel crane engines at JAXPORT's Blount Island Terminal include diesel catalytic converters to reduce the emissions of particulate matter, hydrocarbons, and carbon monoxide. Table 5.48 shows only non-electric equipment. Electric powered cranes are assumed to have no significant air emissions.

Table 5.42 Summary of Cargo Handling Equipment at All Terminals for baseline year 2008

Equipment	Engine Power (HP)	Number of equipment	Average Use (Hours/Year)
Container Cranes (GCT)	1820	5	3785
Jockey Trucks	198	305	231273
Rubber Tired Gantry Crane	915	21	32877.5
Other CHE	222	115	129809
Empty Container Handlers	142	4	6240
Toplifts	280	49	76151

Taylor Engineering obtained the air emission rates for the equipment shown in **Table 5.42** from USEPA's NONROAD model (USEPA, 2005). The NONROAD model used for the year 2008 assumed the use of diesel fuel with 1339 ppm Sulfur. For future years, Taylor Engineering used the projected growth rate percentage from Section 5.7 to obtain the increase the average hours of use for each equipment from the baseline year average hours of use. For years after 2020, Taylor Engineering calculated emission rates for cargo handling equipment using ULSD fuel and 15 ppm sulfur.

Table 5.43 and **Table 5.44** show the total emission load from cargo handling equipment for all the terminals within Jacksonville Harbor for year 2008 and the year of 2020. Similar to Table 5.50, Taylor Engineering estimated the emission load from cargo handling equipment for years 2030 and 2040 – 2070 (Table 5.45). Attachment B shows the detailed calculation for these years.

Table 5.43 Emissions from Cargo Handling Equipment for baseline year of 2008

Equipment Type	Pollutant Emission Load (tons/year)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Container Cranes (GCT)	10.39	2.43	0.68	0.61	0.59	0.67	1018.24
Jockey Trucks	72.92	23.17	6.04	13.21	12.81	11.55	19707.06
Rubber Tired Gantry Crane	93.06	34.21	6.40	6.78	6.58	6.51	9923.90
Other CHE	65.88	21.14	4.98	6.53	6.33	6.87	10575.87
Empty Container Handlers	1.21	0.52	0.10	0.23	0.22	0.18	295.11
Toplifts	21.37	6.70	1.78	3.94	3.83	3.41	5851.50
Total	**264.83**	**88.17**	**19.97**	**31.31**	**30.37**	**29.19**	**47371.69**

Table 5.44 Emissions from Cargo Handling Equipment for year 2020

Equipment Type	Pollutant Emission Load (tons/year)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
Container Cranes (GCT)	7.18	1.27	0.45	0.23	0.22	0.01	1054.66
Jockey Trucks	12.24	4.59	5.03	0.46	0.44	0.13	20400.49
Rubber Tired Gantry Crane	64.80	17.90	4.26	2.53	2.45	0.08	10278.57
Other CHE	27.22	9.24	3.31	1.78	1.73	0.08	10951.71
Empty Container Handlers	0.18	0.08	0.08	0.01	0.01	0.00	305.52
Toplifts	3.57	1.36	1.49	0.14	0.13	0.04	6057.35
Total	**115.19**	**34.44**	**14.62**	**5.14**	**4.98**	**0.34**	**49048.29**

Table 5.45 Total Emission Load from Cargo Handling Equipment for years 2030 and 2040 – 2070

Year	Emission Load (tons/year)						
	NO_x	CO	HC	PM10	PM2.5	SO_2	CO_2
2030	154.35	46.15	19.59	6.88	6.68	0.46	65724.71
2040-2070	259.31	77.53	32.91	11.57	11.22	0.77	110417.52

5.9 Cargo Trucks

JAXPORT and JMTX contacted all the terminals in Jacksonville Harbor to obtain information on the trucks that call at the terminals. The information collected includes estimates of the number of trucks receiving and delivering at each terminal in a given year. Taylor Engineering estimated that one cargo truck drives approximately 35 miles for a round trip transit from Duval County's boundary limit to the port facilities. For future years, Taylor Engineering used the projected growth rate percentage from Section 5.7 to obtain the increase the average vehicle miles traveled by cargo trucks from the baseline year's vehicle miles (Table 5.52).

Starting from 2006, USEPA mandated all trucks to use ULSD fuel. Taylor Engineering used USEPA's Motor Vehicle Emission Simulator (MOVES) model with ULSD fuel for calculating the emission loads from trucks for the year 2008 (USEPA, 2012) (**Table 5.46**). Taylor Engineering used the national database from MOVES model with default values for Duval County, Florida to obtain emission rates (in tons/mile) of various pollutants for years 2008, 2020, and 2030 – 2040. The emission rates multiplied by vehicle miles traveled gives the yearly emission load. Attachment B shows the detailed emission load calculations with emission rates obtained from MOVES model.

Table 5.46 Total emission loads from cargo trucks (tons/year)

Year	Distance Traveled (miles)	Emission Load (tons/year)						
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	32,825,298	553.27	145.25	27.78	30.5	29.62	2.46	78355.8
2020	33,974,183	128.78	42.26	10.46	5.81	5.64	0.57	81153.1
2030	45,525,406	78.95	28.46	8.71	2.01	1.95	0.75	108756
2040	57,076,628	88.63	32.39	10.26	1.84	1.78	0.93	136334

5.10 Fleet Vehicles

JAXPORT and JMTX contacted all the terminals to obtain information on the vehicle fleet (on-road cars, pick-trucks, trucks, and vans owned by and operated for terminal business. The information collected included mileage driven per year by all the fleet vehicles within each terminal by their USEPA classification (**Table 5.47**).

Table 5.47 Mileage of All Fleet Vehicles Operating In Terminals within Jacksonville Harbor

USEPA Vehicle Classification	Typical Vehicles	Total Mileage
Light-Duty Gasoline Vehicles (Passenger Cars)	Cars, Pickups, Vans	1,426,757
Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)	Heavy Duty Pickups	160,790
Light-Duty Diesel Vehicles (Passenger Cars)	Cars, Pickups, Vans	50,244
Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)	Heavy Duty Pickups	51,816

Taylor Engineering used USEPA's Motor Vehicle Emission Simulator (MOVES) model with diesel and gasoline fuel for calculating the emission loads from car and trucks for the baseline and future years (USEPA, 2012). Taylor Engineering used the national database from MOVES model with default values for Duval County, Florida to obtain emission rates (in tons/mile) of various pollutants for years 2008, 2020, 2030 and 2040. The emission rates multiplied by vehicle miles traveled gives the yearly emission load (**Table 5.48**). For future years, Taylor Engineering used the projected growth rate percentage from Section 5.7 to obtain the increase in average vehicle miles traveled by fleet vehicles from the baseline year's vehicle miles. Attachment B shows the detailed emission load calculations with emission rates obtained from MOVES model.

Table 5.48 Total Emission Loads from All Fleet Vehicles (tons/year)

Year	Jacksonville Harbor Fleet Vehicle Emission Load (Tons/year)						
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2.246	13.039	1.270	0.046	0.043	0.024	810.582
2020	0.558	6.267	0.416	0.017	0.016	0.011	729.085
2030	0.473	7.877	0.451	0.018	0.017	0.013	893.332
2040-2070	0.545	9.594	0.528	0.022	0.020	0.016	1103.540

5.11 Locomotives

Currently, three rail operators – Rail Link, Norfolk Southern, and CSX – operate at the Jacksonville Harbor terminals. JAXPORT contacted all the terminals to obtain information on the locomotives that operate within the terminals including yearly hours of use (**Table 5.49)**.

Table 5.49 Train Operators at Jacksonville Harbor Terminals for baseline year 2008

Train Operator	Use Time (Hours/Year)
Rail Link	4590
Norfolk Southern	970
CSX	2184

Taylor Engineering obtained the air emission rates (in tons/hour) for locomotive from USEPA's NONROAD 2008 model for the year 2008 (USEPA, 2005). The NONROAD model used for the year 2008 assumes the use of diesel fuel with 1339 ppm Sulfur. For future years, Taylor Engineering used the projected growth rate percentage from Section 5.7 to obtain the increase in average yearly use time traveled by locomotives from the baseline year's use of locomotives. The emission rates multiplied by locomotives hours of use gives the yearly emission load (**Table 5.50**). Attachment B shows the detailed emission load calculations with emission rates obtained from NONROAD model.

Table 5.50 Total Emission Load from Locomotives for the Baseline and Future Years

Year	Total Use (Hrs/Yr)	Emission Load (tons/year)						
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	7,744	19.92	12.88	2.83	2.02	1.96	1.22	1825.3
2020	8,015	15.09	8.04	1.82	1.07	1.04	0.02	1892.6
2030	10,740	20.22	10.78	2.44	1.44	1.4	0.02	2536.1
2040 – 2070	13,465	25.34	13.51	3.06	1.81	1.75	0.03	3179.6

5.12 Total Harbor Emissions

The total harbor emissions is the sum of emissions emitting from ocean-going vessels, vessel shifts within the harbor, tug operation, tugs during vessel shifts, St. Johns River ferry, dredging equipment used for annual maintenance deepening and harbor deepening, cargo handling equipment, cargo trucks, fleet vehicles and locomotives operating at terminals within the Jacksonville harbor. Section 5.1 – 5.11 provides the methodologies for calculating emissions and provides the annual emission load from nine sources for baseline year of 2008, 2020, 2030, and 2040 – 2070.

Taylor Engineering categorized the emission load from the nine sources into three broad categories:

- Ocean-Going Vessels – This category consists of ocean-going vessels calling into Jacksonville harbor and the vessel shifts that happen within the harbor
- Harbor Fleet Vessels – This category consists of tug boats used to bring ocean-going vessels into the harbor, tug boat used in shifting vessels within the harbor, St. Johns River ferry service, dredging equipment used for annual maintenance and dredging equipment used for harbor deepening
- Landside – This category consists of cargo handling equipment, cargo trucks, fleet vehicles and locomotives operating at various terminals within the Jacksonville Harbor

Tables 5.51 – 5.53 shows the emission load calculated by summing the emission loads from appropriate sources for each of above three categories. Air toxic load calculation requires Volatile Organic Compound (VOC) emission loads to estimate air toxic loads. USACE Savannah SHEP analysis states that VOC is 1.005 times the Hydro Carbon (HC) emission load (USACE, 2012). Taylor Engineering used the above formula to estimate the VOC load. It should be noted that for year 2020 the harbor vessel calculations includes the dredging during deepening emission calculations only and neglect annual dredging emission calculations. For years 2030 and 2040 – 2070, the harbor fleet vessels emissions uses the annual dredging emission calculations and neglects the dredging during deepening emission loads.

Table 5.51 Total Emission Load from Ocean-Going Vessels

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	40	4,407	648	439	161	146	955	153,577	441
2020	40	2,974	711	472	182	166	112	180,254	474
2020	44	2,873	692	462	176	160	108	172,839	464
2020	45	2,866	691	461	176	160	108	172,293	463
2020	47	2,859	690	460	175	159	107	171,769	463
2020	48	2,856	689	460	175	159	107	171,534	462
2030	40	1,846	815	532	214	195	135	216,565	535

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2030	44	1,744	780	514	202	184	126	202,015	516
2030	45	1,734	776	512	201	183	125	200,570	515
2030	47	1,724	773	510	200	182	124	199,230	513
2030	48	1,722	772	510	200	182	124	198,924	512
2040 - 2070	40	2,092	910	588	243	221	155	249,077	591
2040 - 2070	44	1,940	858	562	225	205	141	227,366	564
2040 - 2070	45	1,923	852	558	223	203	140	225,012	561
2040 - 2070	47	1,906	846	555	221	201	138	222,500	558
2040 - 2070	48	1,903	845	555	221	201	138	222,095	557

Table 5.52 Total Emission Load from Harbor Fleet

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	40	1,633	160	55	71	69	62	85,318	55
2020	40	1,949	186	67	86	83	62	101,807	67
2020	44	2,332	198	87	108	105	1	122,701	88
2020	45	2,395	203	90	111	108	1	126,085	90
2020	47	2,546	216	95	118	115	1	134,185	96
2020	48	2,640	225	99	122	119	1	139,210	99
2030	40	2,263	212	79	101	97	62	118,205	79
2030	44	2,128	201	74	94	91	62	111,162	74
2030	45	2,117	200	73	94	91	62	110,614	74
2030	47	2,107	199	73	93	90	62	110,098	73
2030	48	2,105	199	73	93	90	62	109,983	73
2040 - 2070	40	2,543	235	89	114	110	62	132,872	90
2040 - 2070	44	2,336	218	81	104	101	62	122,046	82
2040 - 2070	45	2,319	217	81	103	100	62	121,163	81
2040 - 2070	47	2,301	215	80	103	99	62	120,218	80
2040 - 2070	48	2,298	215	80	102	99	62	120,060	80

Table 5.53 Total Emission Load from Landside

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	40	840	259	52	64	62	33	128,363	52
2020	40	260	91	27	12	12	1	132,823	27
2020	44	260	91	27	12	12	1	132,823	27
2020	45	260	91	27	12	12	1	132,823	27
2020	47	260	91	27	12	12	1	132,823	27

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2020	48	260	91	27	12	12	1	132,823	27
2030	40	254	93	31	10	10	1	177,910	31
2030	44	254	93	31	10	10	1	177,910	31
2030	45	254	93	31	10	10	1	177,910	31
2030	47	254	93	31	10	10	1	177,910	31
2030	48	254	93	31	10	10	1	177,910	31
2040 - 2070	40	374	133	47	15	15	2	251,035	47
2040 - 2070	44	374	133	47	15	15	2	251,035	47
2040 - 2070	45	374	133	47	15	15	2	251,035	47
2040 - 2070	47	374	133	47	15	15	2	251,035	47
2040 - 2070	48	374	133	47	15	15	2	251,035	47

Taylor Engineering obtained the total emission load for Jacksonville harbor (Table 5.54) by adding emission load for each pollutant from Tables 5.51 – 5.53.

Table 5.54 Total Emission Load for Port of Jacksonville (Jacksonville Harbor)

Year	Depth (feet)	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	40	6,880	1,067	546	296	277	1,049	367,259	549
2020	40	5,183	988	566	281	261	175	414,883	569
2020	44	5,465	981	576	297	277	110	428,363	579
2020	45	5,520	985	578	299	279	110	431,200	581
2020	47	5,665	997	583	306	286	110	438,778	586
2020	48	5,756	1,005	586	310	290	109	443,567	589
2030	40	4,362	1,121	642	326	302	198	512,681	645
2030	44	4,126	1,074	619	307	285	189	491,088	622
2030	45	4,105	1,069	616	305	284	188	489,094	619
2030	47	4,086	1,065	614	304	282	187	487,238	617
2030	48	4,081	1,065	614	304	282	187	486,817	617
2040 - 2070	40	5,009	1,279	724	372	346	218	632,984	728
2040 - 2070	44	4,650	1,209	690	345	320	205	600,447	693
2040 - 2070	45	4,616	1,202	686	342	318	204	597,210	689
2040 - 2070	47	4,581	1,194	682	339	315	202	593,753	685
2040 - 2070	48	4,575	1,193	681	339	315	202	593,189	685

5.13 Air Toxics

USEPA requires calculating air toxics discharged in the air while carrying out various operations within the harbor. Air toxics loads are generally determined as fractions of specific criteria pollutant discharges. The air toxics emission rates are a proportion of other parameters such as VOC and PM 10 (**Table 5.55**).

Taylor Engineering obtained information from the USEPA's National Mobile Inventory Model (NMIM) Source Classification Code (SCC) database on the ratios of specific air toxics to other physical parameters (USEPA, 2012). The City of Jacksonville publishes an annual report with air toxic data from the monitoring stations located within City of Jacksonville/Duval County limits (COJ, 2008). Taylor Engineering used the City's air toxic chemical list and USEPA's air toxic ratios for estimating the air toxics within the harbor.

Table 5.55 Air Toxic Pollutant Ratios

Air Toxic Pollutant	Criteria Pollutant	Air Toxic Ratio
Anthracene	PM10	4.3E-07
Pyrene	PM10	2.9E-06
Benzo(g,h,i)perylene	PM10	1.9E-07
Indeno(1,2,3,c,d)pyrene	PM10	7.9E-08
Benzo(b)fluoranthene	PM10	4.9E-07
Fluoranthene	PM10	0.000017
Benzo(k)fluoranthene	PM10	3.5E-07
Acenaphthylene	PM10	0.000084
Chrysene	PM10	1.9E-06
Benzo(a)pyrene	PM10	3.5E-07
Dibenzo(a,h)anthracene	PM10	2.9E-09
Benz(a)anthracene	PM10	7.1E-07
Acenaphthene	PM10	0.0001
Phenanthrene	PM10	0.00026
Fluorene	PM10	0.0001
Naphthalene	PM10	0.00046
Ethyl Benzene	VOC	0.0031
Styrene	VOC	0.000594
1,3-Butadiene	VOC	0.001862
Acrolein	VOC	0.003032

Air Toxic Pollutant	Criteria Pollutant	Air Toxic Ratio
Toluene	VOC	0.014967
Hexane	VOC	0.001591
Propionaldehyde	VOC	0.0118
Xylene	VOC	0.010582
Formaldehyde	VOC	0.118155
2,2,4-Trimethylpentane	VOC	0.00066
Benzene	VOC	0.020344
Acetaldehyde	VOC	0.05308

Taylor Engineering used the air toxic ratios from Table 5.61 and the total port emission loads of VOC and PM10 from Table 5.54 to obtain the air toxic pollutant load for the various air toxic pollutants listed in Table 5.55. Table 5.56 shows the estimated air toxic load from Jacksonville Harbor for baseline year 2008, and future years 2020, 2030, and 2040 – 2070 with the TSP depth of 47 feet. Attachment B shows a detailed calculation of air toxic load for all other depths.

Table 5.56 Air Toxic Pollutant Load Estimates for Port of Jacksonville

Air Toxic Pollutant	Air Toxic Load (tons/year)			
	2008	2020 (TSP Depth 47 feet)	2030 (TSP Depth 47 feet)	2040-2070 (TSP Depth 47 feet)
Anthracene	0.0001	0.0001	0.0001	0.0001
Pyrene	0.0009	0.0009	0.0009	0.0010
Benzo(g,h,i)perylene	0.0001	0.0001	0.0001	0.0001
Indeno(1,2,3,c,d)pyrene	0.0000	0.0000	0.0000	0.0000
Benzo(b)fluoranthene	0.0001	0.0001	0.0001	0.0002
Fluoranthene	0.0050	0.0052	0.0052	0.0058
Benzo(k)fluoranthene	0.0001	0.0001	0.0001	0.0001
Acenaphthylene	0.0249	0.0257	0.0255	0.0285
Chrysene	0.0006	0.0006	0.0006	0.0006
Benzo(a)pyrene	0.0001	0.0001	0.0001	0.0001
Dibenzo(a,h)anthracene	0.0000	0.0000	0.0000	0.0000

Air Toxic Pollutant	Air Toxic Load (tons/year)			
	2008	2020 (TSP Depth 47 feet)	2030 (TSP Depth 47 feet)	2040-2070 (TSP Depth 47 feet)
Benz(a)anthracene	0.0002	0.0002	0.0002	0.0002
Acenaphthene	0.0296	0.0306	0.0304	0.0339
Phenanthrene	0.0770	0.0794	0.0790	0.0881
Fluorene	0.0296	0.0306	0.0304	0.0339
Naphthalene	0.1362	0.1406	0.1398	0.1559
Ethyl Benzene	1.70	1.82	1.91	2.13
Styrene	0.33	0.35	0.37	0.41
1,3-Butadiene	1.02	1.09	1.15	1.28
Acrolein	1.66	1.78	1.87	2.08
Toluene	8.21	8.77	9.24	10.26
Hexane	0.87	0.93	0.98	1.09
Propionaldehyde	6.47	6.91	7.28	8.09
Xylene	5.81	6.20	6.53	7.25
Formaldehyde	64.82	69.21	72.94	80.99
2,2,4-Trimethylpentane	0.36	0.39	0.41	0.45
Benzene	11.16	11.92	12.56	13.95
Acetaldehyde	29.12	31.09	32.77	36.39

City of Jacksonville's air toxic report (COJ, 2008) for 2008 shows the following pollutants as the top Hazardous Air Pollutants (HAP) in Jacksonville/Duval County.

- Styrene
- Xylene
- Toluene
- Hexane
- Benzene

Taylor Engineering obtained USEPA's estimated air toxic pollutant load for Jacksonville/Duval County for the HAP pollutants (excluding Xylene) from USEPA's 2008 National Emission Inventory database and compared it with the estimated air toxic load within the harbor (Table 5.57). Table 5.63 shows that for the baseline year of 2008

Port of Jacksonville is not a significant contributor to the Jacksonville/Duval County HAP toxic load.

Table 5.57 Comparison of Port of Jacksonville's Air Toxic Load with USEPA's estimated Air Toxic Load

Air Toxic Pollutant	Emission Load from EPA 2008 NEI Data (tons/year)	Estimated Air Toxic Load in the Harbor in 2008 (tons/year)	Percentage of EPA's load
Ethyl Benzene	287.10	1.70	0.59%
Styrene	37.48	0.33	0.87%
Toluene	1,513.92	8.21	0.54%
Hexane	395.57	0.87	0.22%
Benzene	495.86	11.16	2.25%

Port of Jacksonville air toxic load calculations show that benzene is the highest contributor among all the top HAP pollutants within Jacksonville and contributes 2.25% of the total of Jacksonville's benzene load (Table 5.57). For years 2040 – 2070 with the TSP depth of 47 feet, Table 5.56 shows the benzene load increases to 13.95 tons/year. This benzene load equals about 2.8% of Jacksonville's total benzene load. Taylor Engineering concludes that Port of Jacksonville would not significantly contribute to Jacksonville/Duval County's air toxic load for future years.

5.14 Greenhouse Gases

According to USEPA, carbon dioxide (CO_2), the primary greenhouse gas associated with combustion of diesel (and other fossil fuels), accounted for about 96 percent of the transportation sector's global warming potential-weighted GHG emissions for 2003 (USEPA, 2009). Methane (CH_4) and nitrous oxide (N_2O) together account for about 2 percent of the transportation total GHG emissions in 2003. Both of these gases are released during diesel fuel consumption (although in much smaller quantities than CO_2) and are affected by vehicle emissions control technologies. In addition to methane and nitrous oxide, elemental carbon is also considered as a main pollutant source to climate change.

USEPA report states the methodologies to estimate methane, nitrous oxide and elemental carbon loads (USEPA, 2009). USACE-Savannah's SHEP air quality analysis shows that ocean-going vessels and harbor craft vessels are the major sources of greenhouse gases (USACE, 2012). USEPA report (USEPA, 2009) states that methane and nitrous oxide loads should be estimated from ocean-going vessels and harbor craft's carbon dioxide (CO_2) load using the following formula:

CH_4 gas load = $CO_2/21$
N_2O gas load = $CO_2/310$

Tables 5.57 and 5.58 provide the carbon dioxide load from ocean-going vessels and harbor craft.

The USACE-Savannah SHEP air quality analysis states EPA's SPECIATE4 model for emissions of PM2.5 can provide the elemental carbon emission load. For diesel-powered ocean-going vessels and harbor craft vessels, the diesel commercial marine vessel (SCC 2280002000) sector in the SPECIATE 4 model assigns an emission fraction of 77.12% elemental carbon. Because a PM 2.5 load is approximately 97% of the PM 10 load, the elemental carbon load can be calculated using the following formula:

Elemental Carbon Load = 0.7712 * 0.97 * PM10

Table 5.51 and Table 5.52 provide the PM 10 load from ocean-going vessels and harbor crafts.

Table 5.58 shows the emission load from methane, nitrous oxides, and elemental carbon estimated by using the formulas from above paragraphs. Table 5.64 shows that for future years of 2040 – 2070 and with the TSP depth of 47 feet, the nitrous oxide gas and methane load increases by 43%, and elemental carbon increases by 39.4% when compared with the baseline year of 2008 values. Taylor Engineering believes these forecasted increases in greenhouse gases loads are conservative. In future, Port of Jacksonville would see an increase in LNG-powered ocean-going vessels as opposed to diesel-powered ocean-going vessels. LNG-powered ocean-going vessels emit significantly lower loads of carbon dioxide and PM 10. Hence, in future, the greenhouse gases at the Port of Jacksonville would be significantly lower due to a shift from diesel-powered ocean-going vessels to LNG vessels.

Table 5.58 Estimated Greenhouse Gases and Elemental Carbon Load for Port of Jacksonville

Year	Depth (feet)	Emission Load (tons/year)				
		CO_2	PM 10	N_20	CH_4	Elemental Carbon
2008	40	238,896	232	770.63	11,375.98	173.74
2020	40	282,060	269	909.87	13,431.44	200.89
2020	44	295,540	285	953.36	14,073.34	212.96
2020	45	298,377	287	962.51	14,208.45	214.76
2020	47	305,954	294	986.95	14,569.26	219.58
2020	48	310,744	298	1,002.40	14,797.32	222.63
2030	40	334,771	315	1,079.91	15,941.46	235.79
2030	44	313,178	297	1,010.25	14,913.22	222.04

Year	Depth (feet)	Emission Load (tons/year)				
		CO_2	PM 10	N_20	CH_4	Elemental Carbon
2030	45	311,183	295	1,003.82	14,818.25	220.78
2030	47	309,328	294	997.83	14,729.90	219.62
2030	48	308,907	293	996.47	14,709.86	219.36
2040 -2070	40	381,950	357	1,232.10	18,188.07	267.15
2040 -2070	44	349,412	329	1,127.13	16,638.66	246.42
2040 -2070	45	346,175	327	1,116.69	16,484.52	244.37
2040 -2070	47	342,718	324	1,105.54	16,319.91	242.20
2040 -2070	48	342,155	323	1,103.72	16,293.08	241.84

5.15 Analysis of Port of Jacksonville's Air Emissions

Taylor Engineering compared Port of Jacksonville's emission data for the baseline year of 2008 with the Duval County's observed emission load data for the year 2008. EPA's National Emission Inventory (NEI) data for the year 2008 provided emission load data for the following pollutants (USEPA, 2008).

- Nitrous Oxide (NO_x)
- Hydro Carbon (HC)
- Particulate Matter less than 10 microns (PM 10)
- Particulate Matter less than 2.5 microns (PM 2.5)
- Sulfur Dioxide (SO_2)
- Carbon Dioxide (CO_2)
- Volatile Organic Carbons (VOC)

Because the USEPA's 2008 NEI data did not include Carbon Monoxide (CO), Taylor Engineering obtained the CO emission load for Duval County from City of Jacksonville's Air Emission Data for the year 2002 (COJ, 2002). Table 5.59 shows the emission load for various pollutants obtained from USEPA and City of Jacksonville.

Table 5.59 Observed Emission Load within Duval County for the year 2008

Year	Emission Load (tons/year)							
	NO_X	CO*	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	61,636	273,996	46,382	10,690	4,776	18,528	7,664,294	46,614

* CO emission load from year 2002

In Table 5.60, Taylor Engineering compared the Duval County emission load (Table 5.59) with the Port of Jacksonville's total emission load (Table 5.54) for the baseline year of 2008.

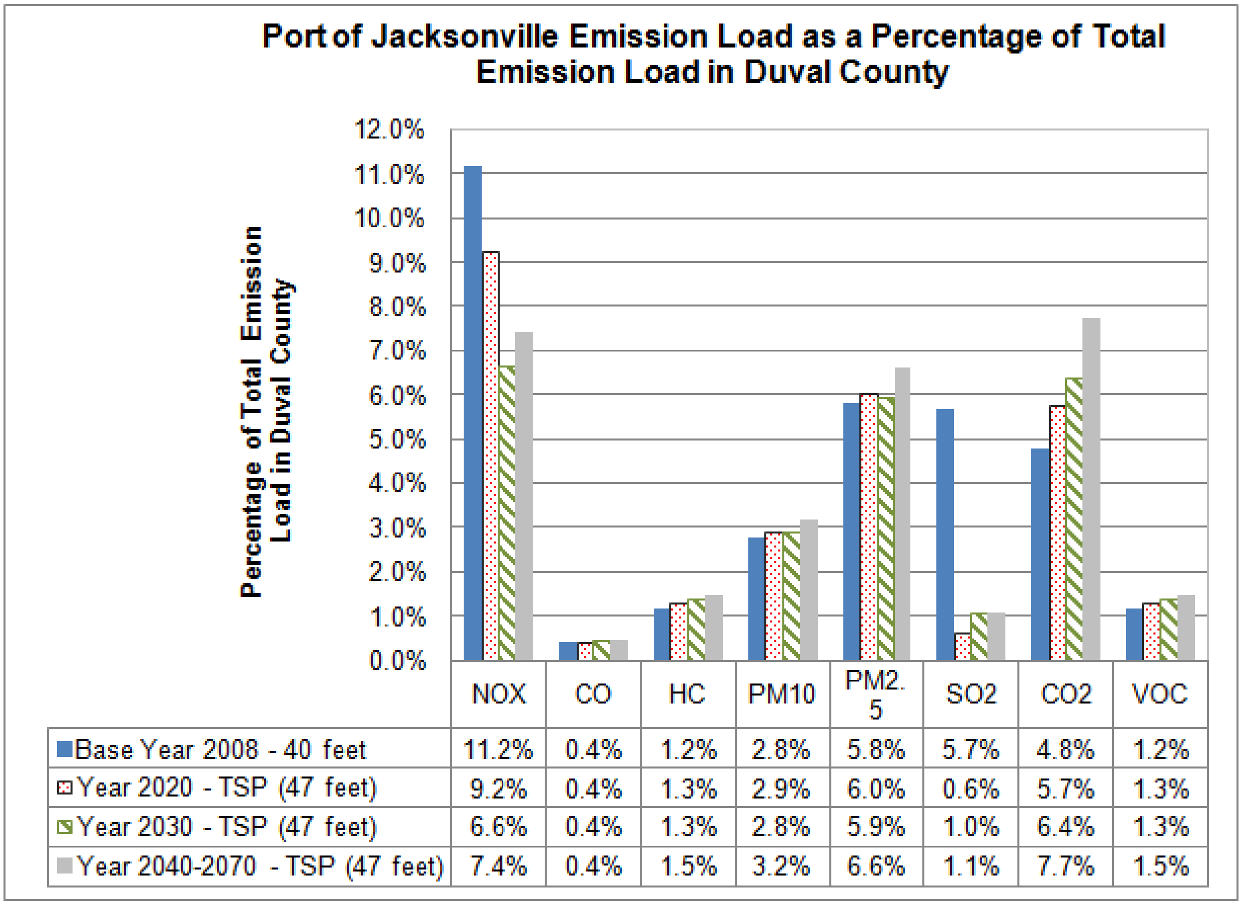
Table 5.60 Comparison of Port of Jacksonville's Emissions with Duval County Emissions

Location	Emission Load (tons/year)							
	NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
Port	6,880	1,067	546	296	277	1,049	367,259	549
Duval County	61,636	273,996	46,383	10,690	4,776	18,529	7,664,294	46,615
Port's Percentage	11.2%	0.4%	1.2%	2.8%	5.8%	5.7%	4.8%	1.2%

For the baseline year of 2008, Port of Jacksonville contributed about 11% of Duval County's NO_X load (Table 5.60). Taylor Engineering compared the percentage of NO_X total load at Port of Jacksonville with the percentage of NO_X total load at Port of Savannah and found that Port of Jacksonville's percentage of total NO_X load is comparable to the percentage of total NO_X load at Port of Savannah. Port of Savannah contributes about 13.5% of the NO_X load to Chatham County's total emission load (USACE, 2012). Figure 5.2 compares the percentage of Port of Jacksonville's emission load for various pollutants for the baseline year of 2008, years 2020, 2030, and 2040 – 2070 with the TSP depth of 47 feet with the observed Duval County emission load for the year 2008.

For future years, the emission rate for NO_X decreases and hence results in a gradual decrease in NO_X emission loads. For pollutants other than NO_X, emission loads for the baseline year of 2008 are less than 6%; thus, Taylor Engineering concluded that Port of Jacksonville does not significantly contribute to Duval County's emission load. For future years, all pollutants except NO_X and SO_2 show that the pollutant's emission load to Duval County's emission load will increase by a small percentage. The emission load for SO_2 reduces drastically after year 2016 because the emission rates decreases drastically after year 2016. Taylor Engineering concludes that Port of Jacksonville will not significantly contribute to Duval County's emission load in the future.

Figure 5.2 Comparison of Port of Jacksonville Emission load with Duval County Load for Baseline and Future Years



Taylor Engineering divided the total emission loads by JAXPORT terminals and private terminals for the baseline year of 2008. Table 5.61 shows the emission loads from ocean-going vessels and landside at JAXPORT and private terminals. Table 5.61 excludes emissions from harbor fleet vessels because these vessels are not directly associated with the terminal activities.

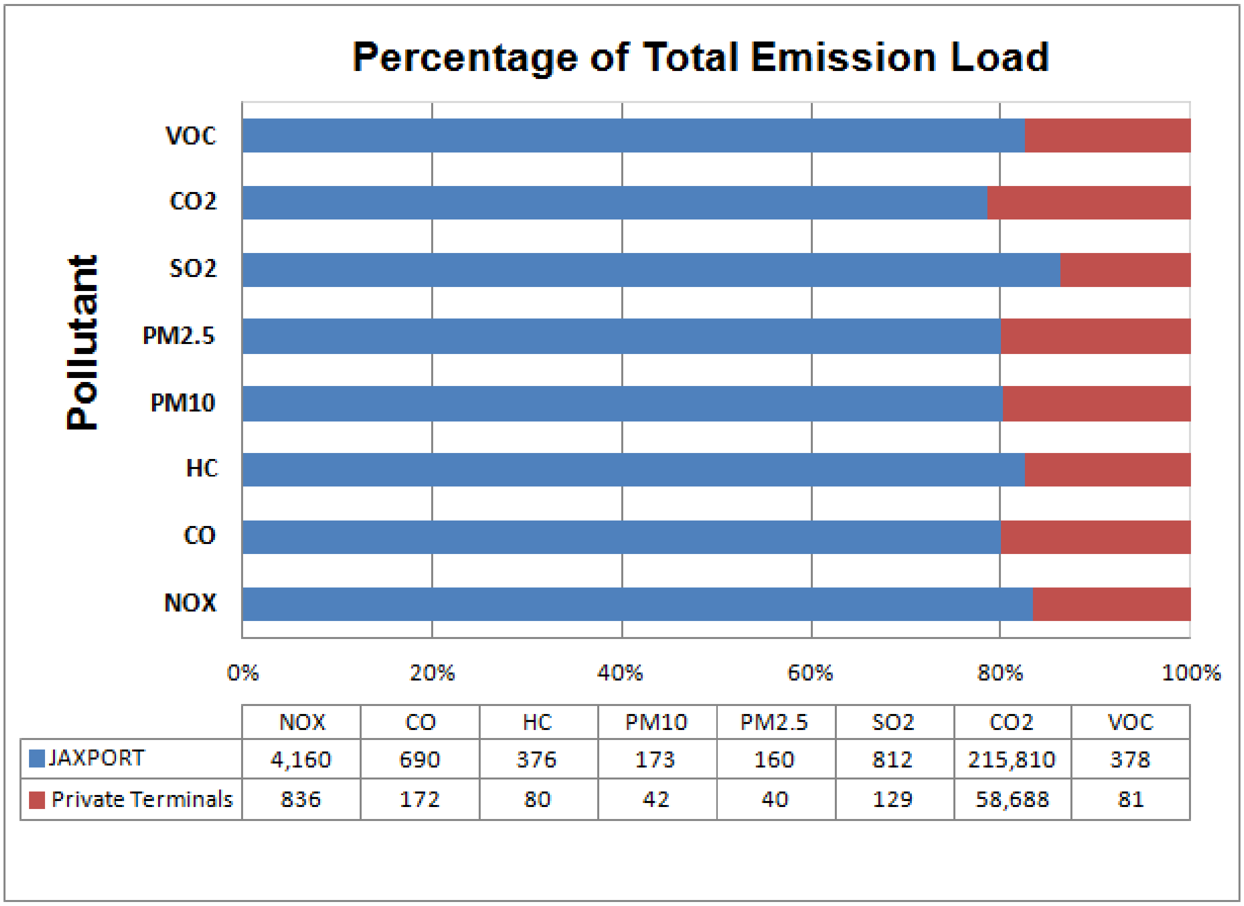
Table 5.61 Emission Loads at JAXPORT and Private Terminals

Year	Location	Emission Load (tons/year)							
		NO_X	CO	HC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	VOC
2008	JAXPORT	4,160	690	376	173	160	812	215,810	378
2008	Private Terminals	836	172	80	42	40	129	58,688	81

Figure 5.3 plots JAXPORT and private terminals emission load as a percentage of the total emission load obtained for each pollutant from Table 5.61. JAXPORT terminals contribute approximately 80% of the total emission load for all pollutants. JAXPORT terminals receive about 88% of the total ocean-going vessels that called into Port of Jacksonville for the year 2008. On landside, JAXPORT has a major portion of cargo

handling equipment, cargo trucks, fleet vehicles, and locomotives operating at its terminals compared with the private terminals. Taylor Engineering concludes that JAXPORT's emission load contribution of approximately 80% of the total emission load for the baseline year is a reasonable estimate.

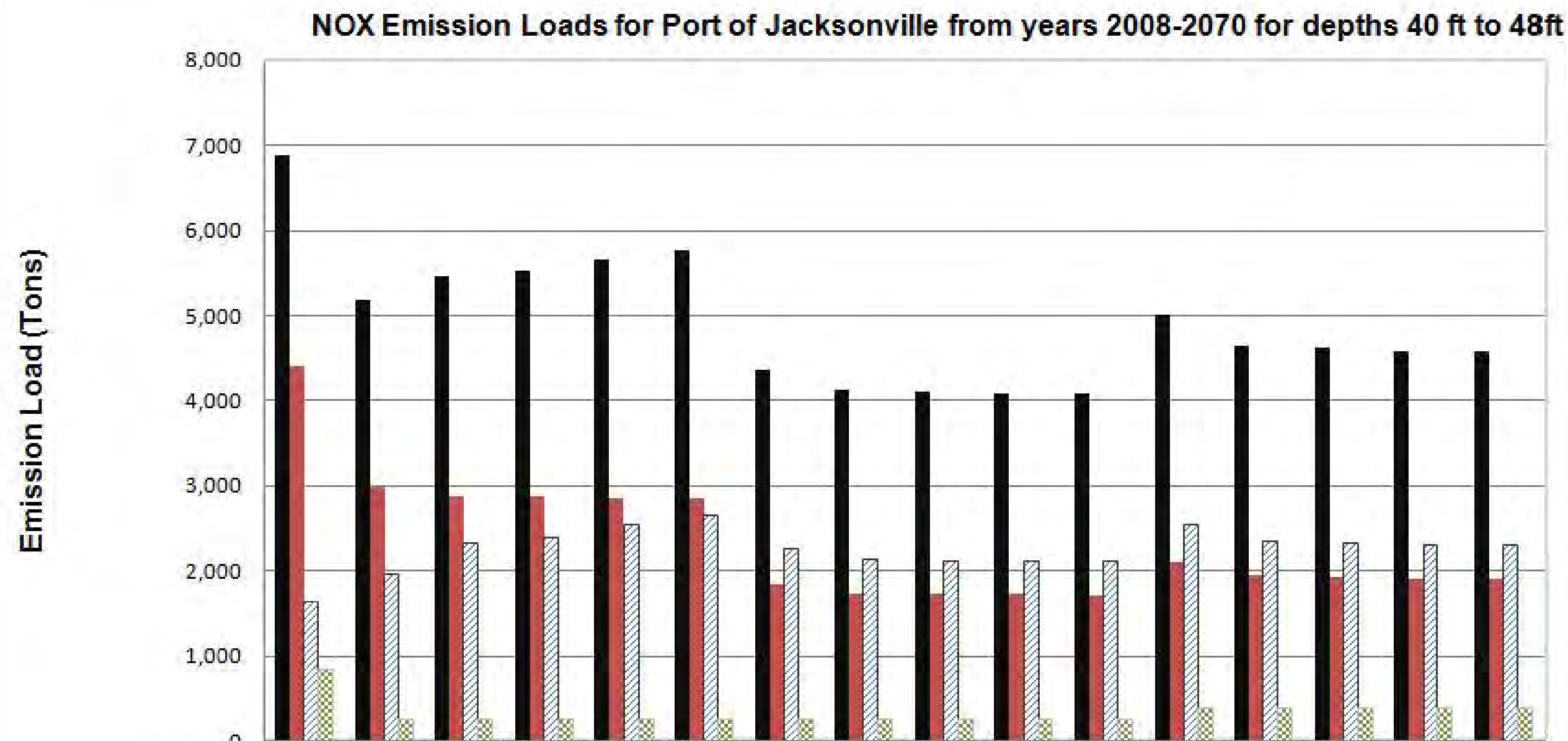
Figure 5.3 Distribution of Emission Loads between JAXPORT and Private Terminals (excluding the Harbor Fleet) for Base Year 2008



	NOX	CO	HC	PM10	PM2.5	SO2	CO2	VOC
JAXPORT	4,160	690	376	173	160	812	215,810	378
Private Terminals	836	172	80	42	40	129	58,688	81

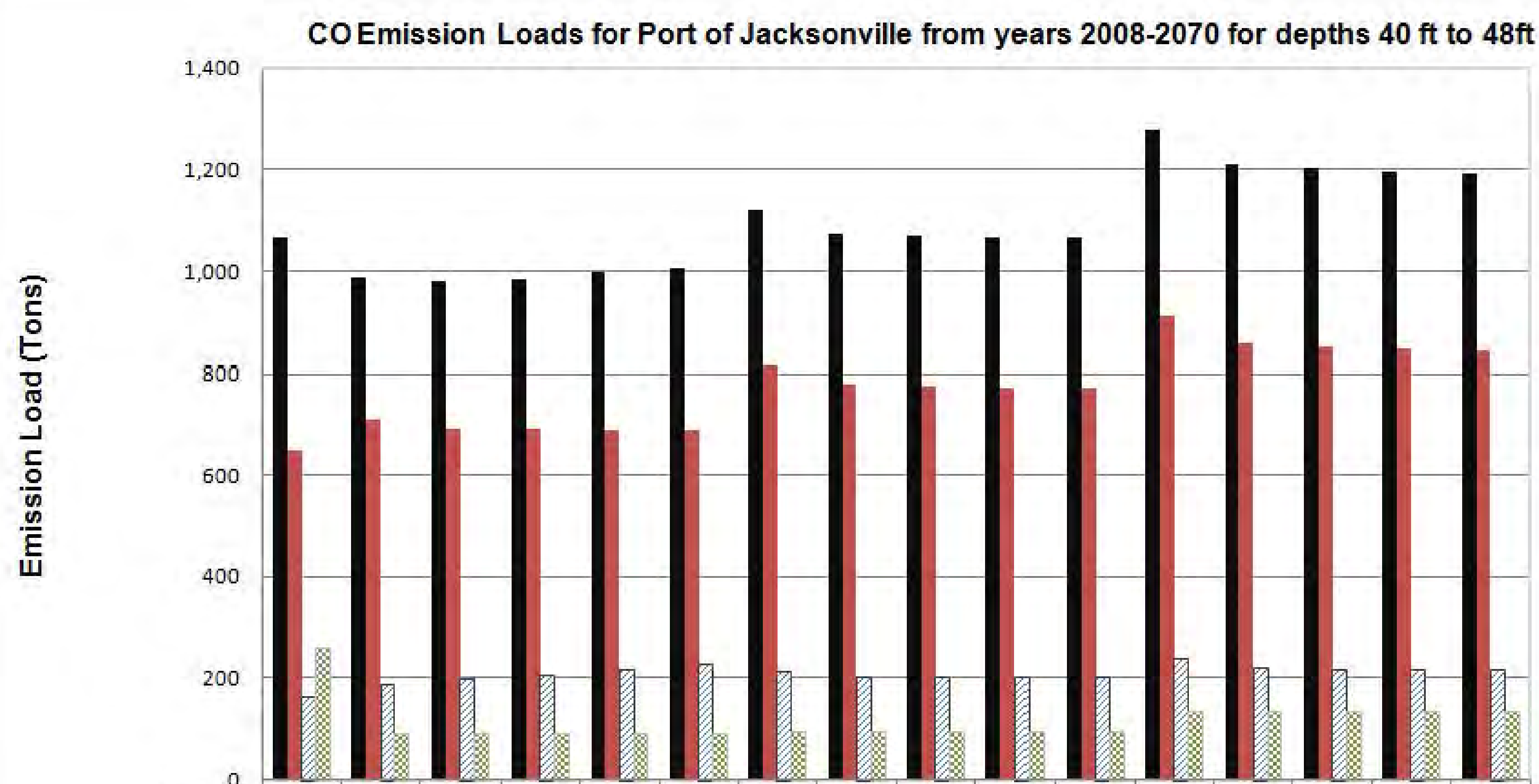
Figures 5.4 – 5.11 show the distribution of emission loads for each criteria pollutant in three categories – Ocean-Going Vessels, Harbor Fleet, and Landside. Emission loads are compared with the total emission load for a given year and water depth. These figures indicate that ocean-going vessels are the major contributor to the emission load for all pollutants except NO_X and CO_2. Landside emissions for CO_2 are either equivalent or greater than ocean-going vessels. Cargo trucks and cargo handling equipment emit CO_2 and are major contributors to landside emissions.

Figure 5.4 Total NO_x Emissions Load at Port of Jacksonville for All Years and Alternative Depths



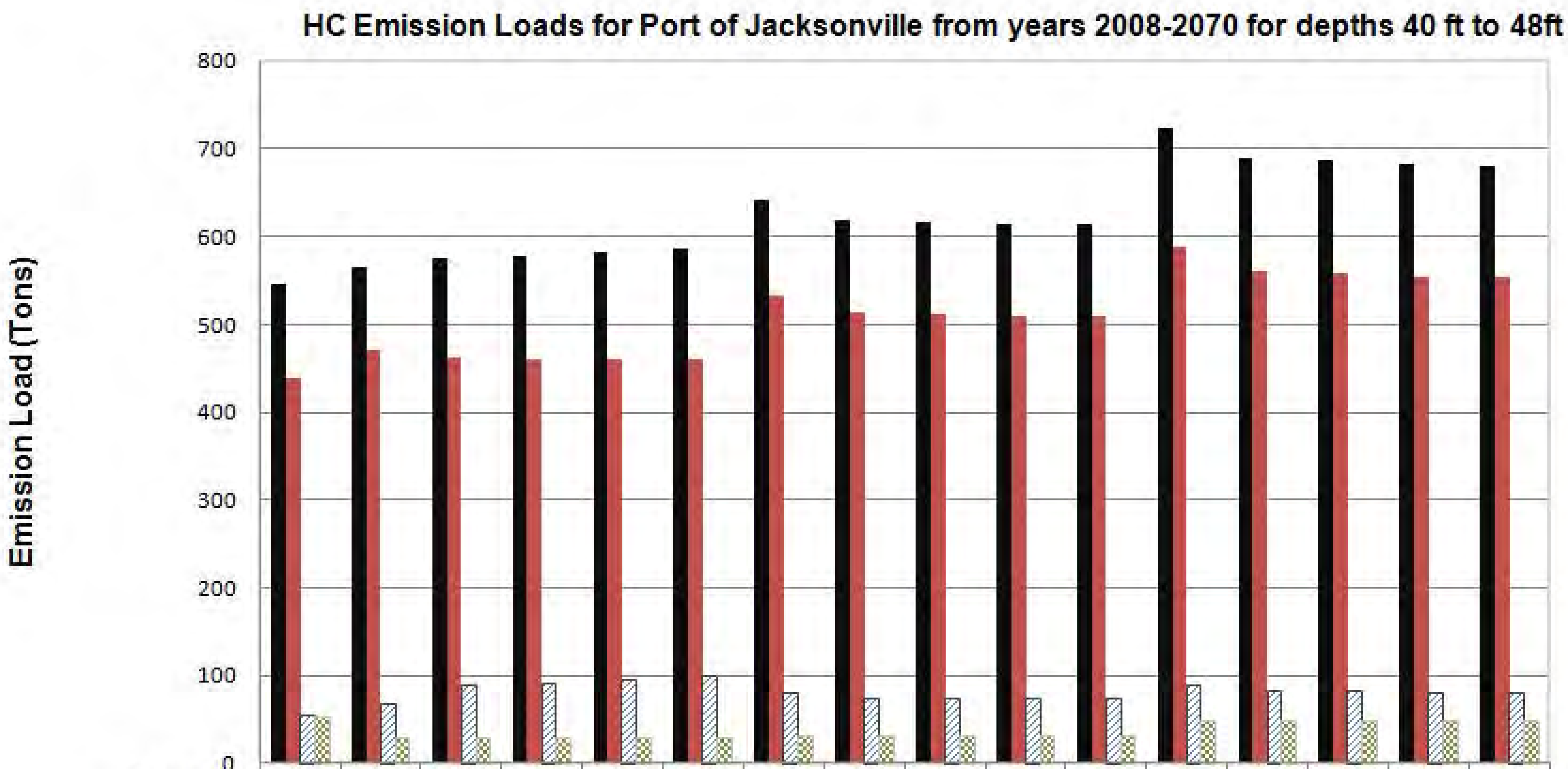
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	6,880	5,183	5,465	5,520	5,665	5,756	4,362	4,126	4,105	4,086	4,081	5,009	4,650	4,616	4,581	4,575
Ocean Going Vessels	4,407	2,974	2,873	2,866	2,859	2,856	1,846	1,744	1,734	1,724	1,722	2,092	1,940	1,923	1,906	1,903
Harbor Fleet	1,633	1,949	2,332	2,395	2,546	2,640	2,263	2,128	2,117	2,107	2,105	2,543	2,336	2,319	2,301	2,298
Landside	840	260	260	260	260	260	254	254	254	254	254	374	374	374	374	374

Figure 5.5 Total CO Emissions Load at Port of Jacksonville for All Years and Alternative Depths



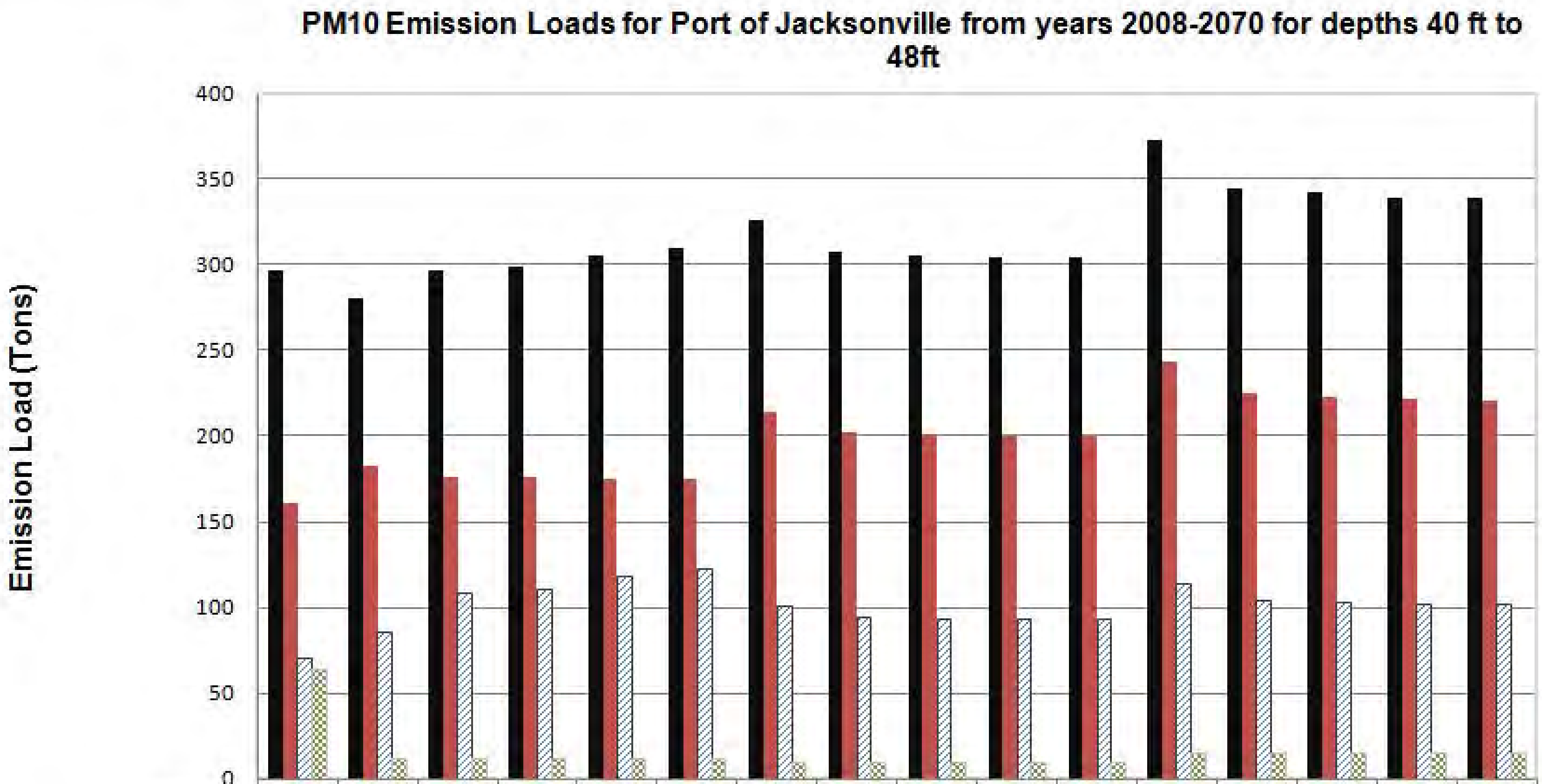
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	1,067	988	981	985	997	1,005	1,121	1,074	1,069	1,065	1,065	1,279	1,209	1,202	1,194	1,193
Ocean Going Vessels	648	711	692	691	690	689	815	780	776	773	772	910	858	852	846	845
Harbor Fleet	160	186	198	203	216	225	212	201	200	199	199	235	218	217	215	215
Landside	259	91	91	91	91	91	93	93	93	93	93	133	133	133	133	133

Figure 5.6 Total HC Emissions Load at Port of Jacksonville for All Years and Alternative Depths



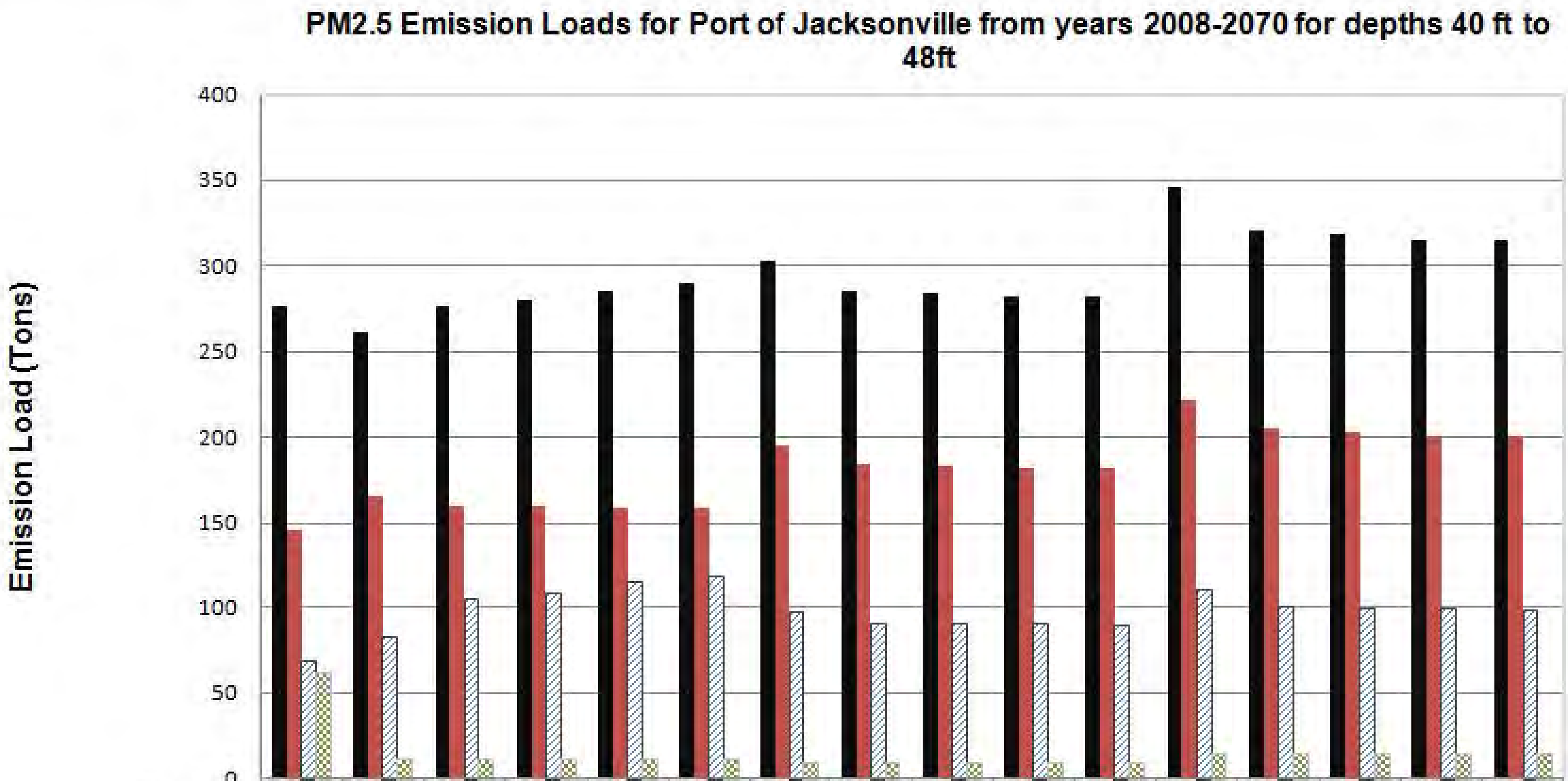
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	546	566	576	578	583	586	642	619	616	614	614	724	690	686	682	681
Ocean Going Vessels	439	472	462	461	460	460	532	514	512	510	510	588	562	558	555	555
Harbor Fleet	55	67	87	90	95	99	79	74	73	73	73	89	81	81	80	80
Landside	52	27	27	27	27	27	31	31	31	31	31	47	47	47	47	47

Figure 5.7 Total PM10 Emissions Load at Port of Jacksonville for All Years and Alternative Depths



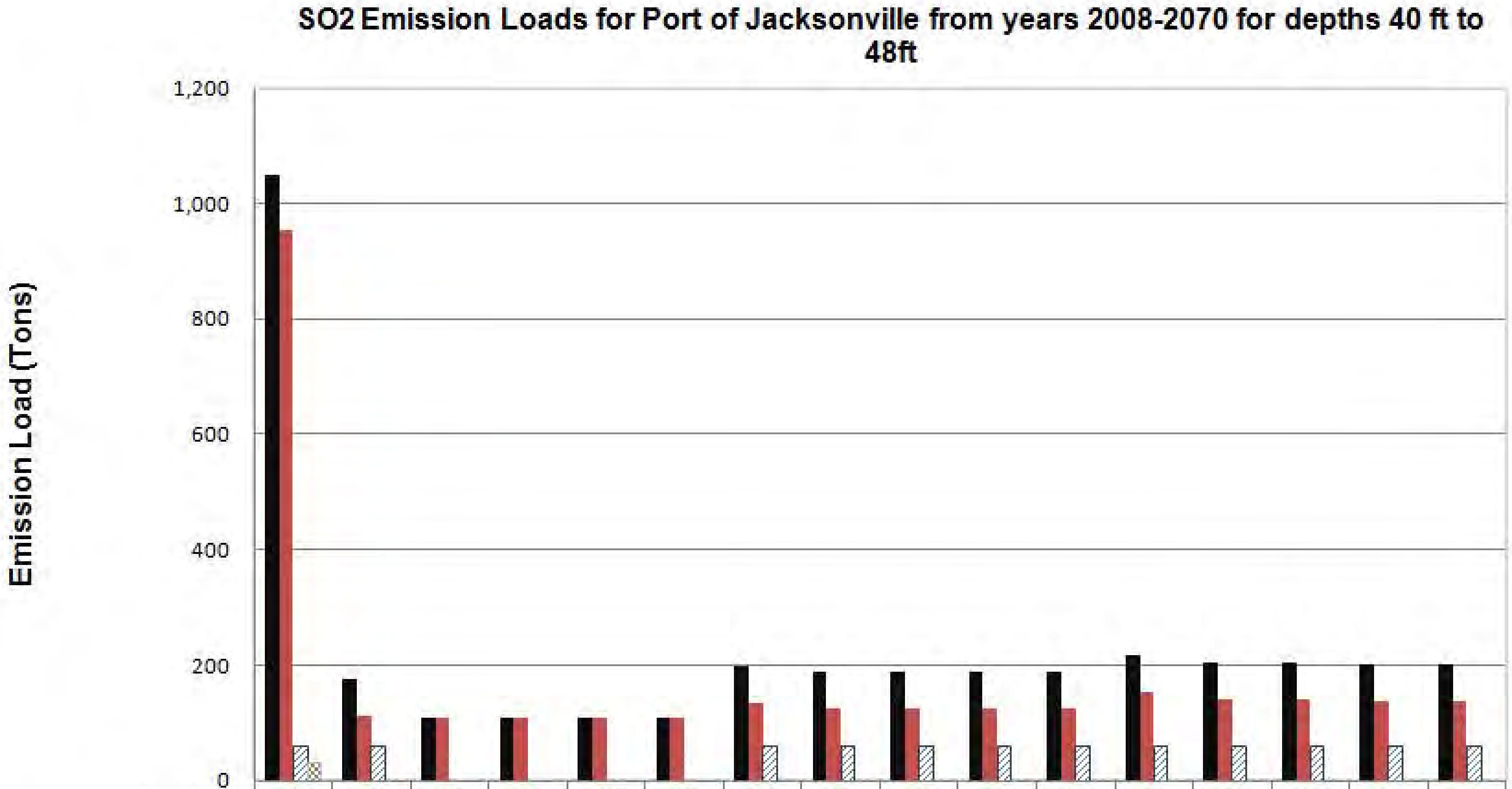
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	296	281	297	299	306	310	326	307	305	304	304	372	345	342	339	339
Ocean Going Vessels	161	182	176	176	175	175	214	202	201	200	200	243	225	223	221	221
Harbor Fleet	71	86	108	111	118	122	101	94	94	93	93	114	104	103	103	102
Landside	64	12	12	12	12	12	10	10	10	10	10	15	15	15	15	15

Figure 5.8 Total PM2.5 Emissions Load at Port of Jacksonville for All Years and Alternative Depths



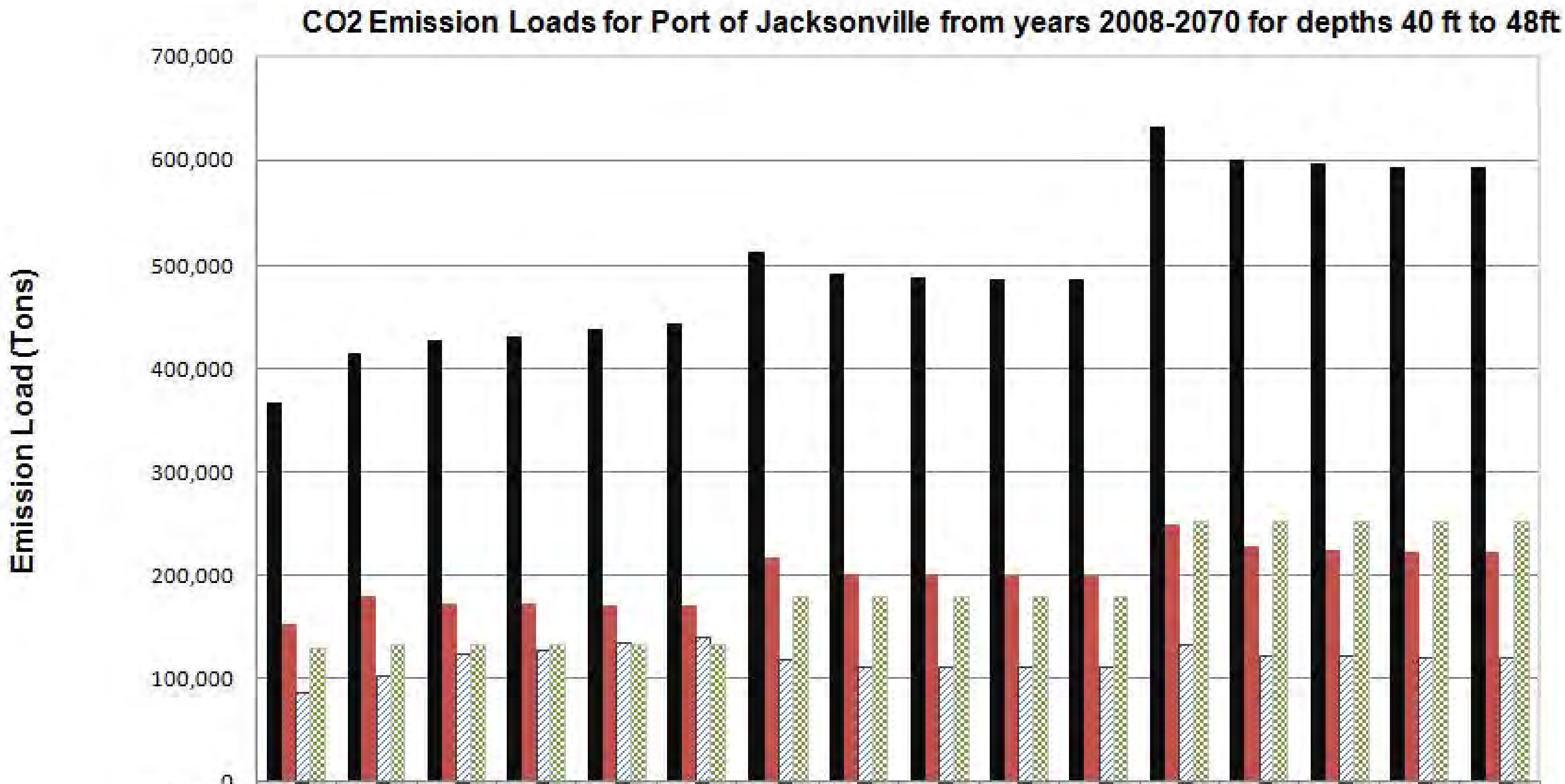
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	277	261	277	279	286	290	302	285	284	282	282	346	320	318	315	315
Ocean Going Vessels	146	166	160	160	159	159	195	184	183	182	182	221	205	203	201	201
Harbor Fleet	69	83	105	108	115	119	97	91	91	90	90	110	101	100	99	99
Landside	62	12	12	12	12	12	10	10	10	10	10	15	15	15	15	15

Figure 5.9 Total SO_2 Emissions Load at Port of Jacksonville for All Years and Alternative Depths



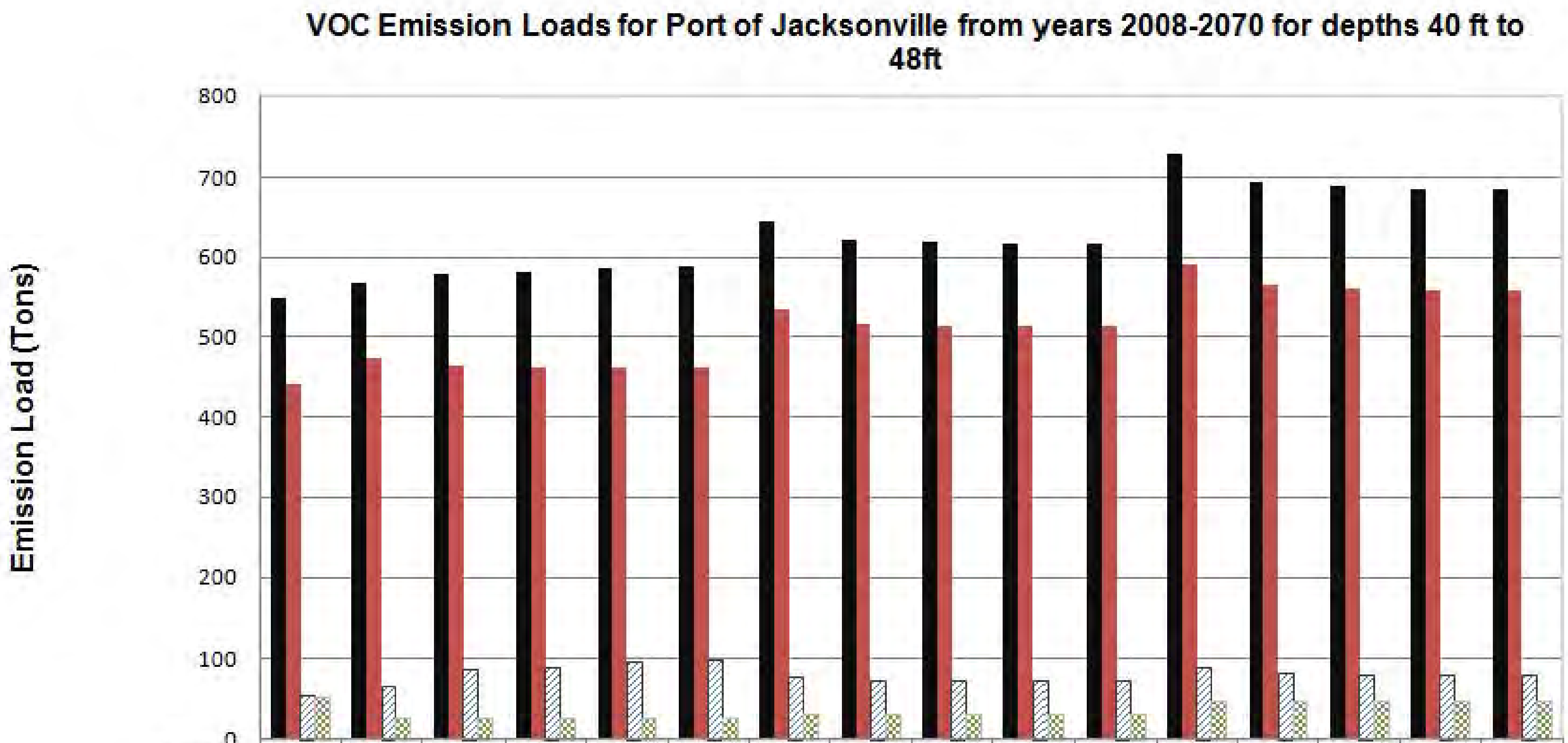
Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	1,049	175	110	110	110	109	198	189	188	187	187	218	205	204	202	202
Ocean Going Vessels	955	112	108	108	107	107	135	126	125	124	124	155	141	140	138	138
Harbor Fleet	62	62	1	1	1	1	62	62	62	62	62	62	62	62	62	62
Landside	33	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2

Figure 5.10 Total CO_2 Emissions Load at Port of Jacksonville for All Years and Alternative Depths



Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	367,25	414,88	428,36	431,20	438,77	443,56	512,68	491,08	489,09	487,23	486,81	632,98	600,44	597,21	593,75	593,18
Ocean Going Vessels	153,57	180,25	172,83	172,29	171,76	171,53	216,56	202,01	200,57	199,23	198,92	249,07	227,36	225,01	222,50	222,09
Harbor Fleet	85,318	101,80	122,70	126,08	134,18	139,21	118,20	111,16	110,61	110,09	109,98	132,87	122,04	121,16	120,21	120,06
Landside	128,36	132,82	132,82	132,82	132,82	132,82	177,91	177,91	177,91	177,91	177,91	251,03	251,03	251,03	251,03	251,03

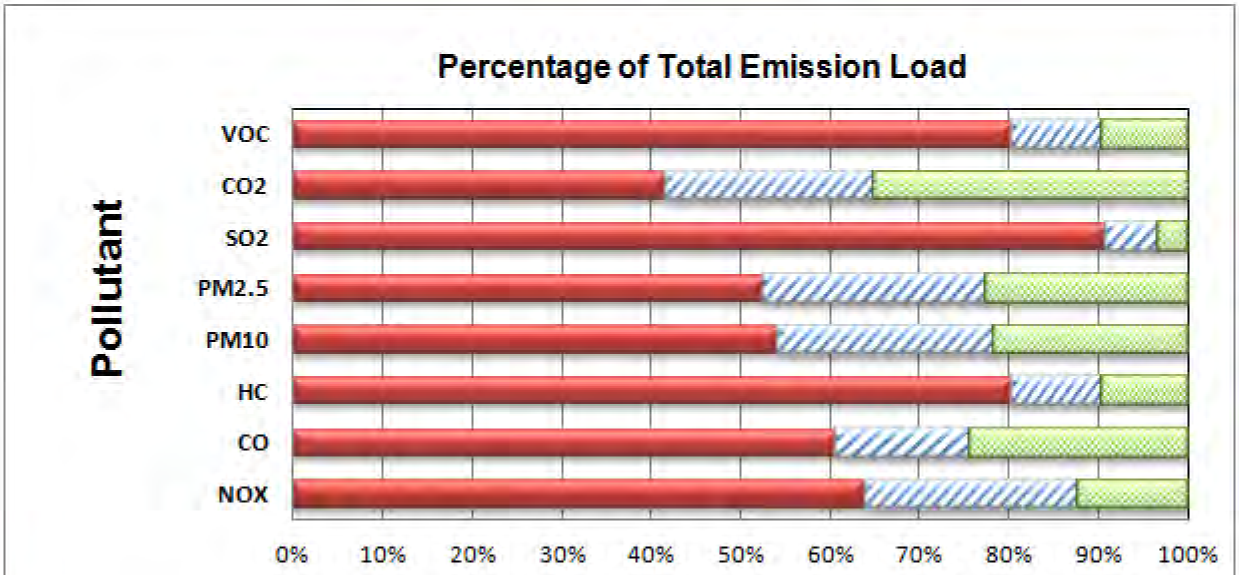
Figure 5.11 Total VOC Emissions Load at Port of Jacksonville for All Years and Alternative Depths



Depth	40	40	44	45	47	48	40	44	45	47	48	40	44	45	47	48
Year	2008	2020	2020	2020	2020	2020	2030	2030	2030	2030	2030	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070	2040 - 2070
Total Emission Load	549	569	579	581	586	589	645	622	619	617	617	728	693	689	685	685
Ocean Going Vessels	441	474	464	463	463	462	535	516	515	513	512	591	564	561	558	557
Harbor Fleet	55	67	88	90	96	99	79	74	74	73	73	90	82	81	80	80
Landside	52	27	27	27	27	27	31	31	31	31	31	47	47	47	47	47

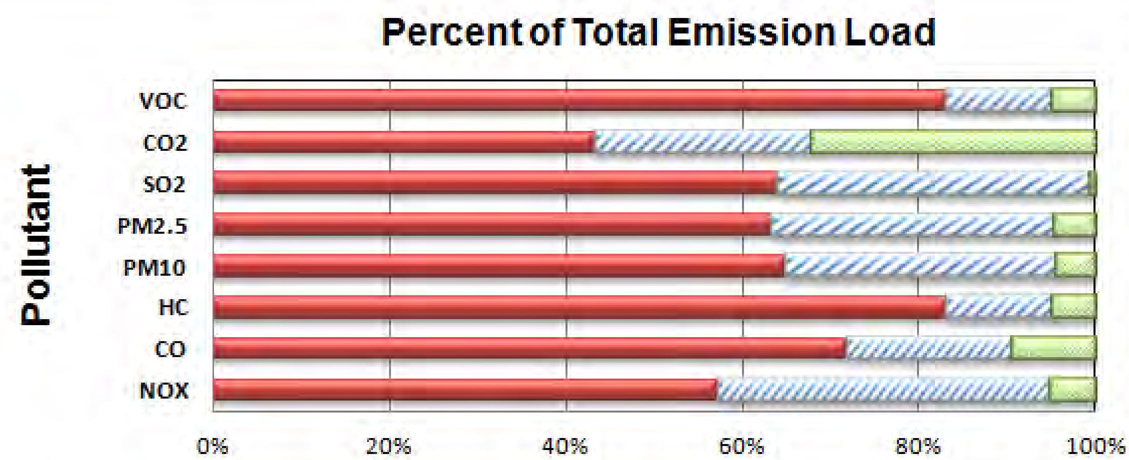
Figures 5.12 – Figure 5.15 show the distribution of emission loads as a percentage to the total emission load for the baseline year of 2008, years 2020, 2030, and 2040 – 2070 with TSP depth of 47 feet. As seen from these figures, the emission load of SO_2 from ocean-going vessels reduces from 90% in the baseline year of 2008 to 68% for years 2040 – 2070. Similarly, NO_X emissions from ocean-going vessels reduce from 65% to approximately 40% for years 2040 – 2070.

Figure 5.12 Percent Emission Load Distribution by Source for Baseline Year 2008



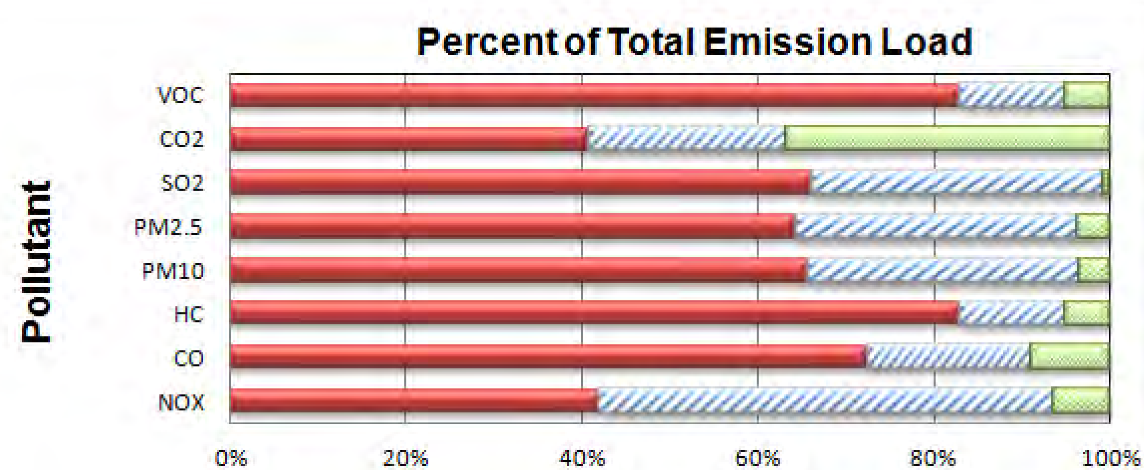
	NOX	CO	HC	PM10	PM2.5	SO2	CO2	VOC
Ocean Going Vessels	4,407	648	439	161	146	955	153,577	441
Harbor Fleet	1,633	160	55	71	69	62	85,318	55
Landside Emissions	840	259	52	64	62	33	128,363	52

Figure 5.13 Percent Emission Load Distribution by Source for Year 2020 and TSP Depth of 47 feet



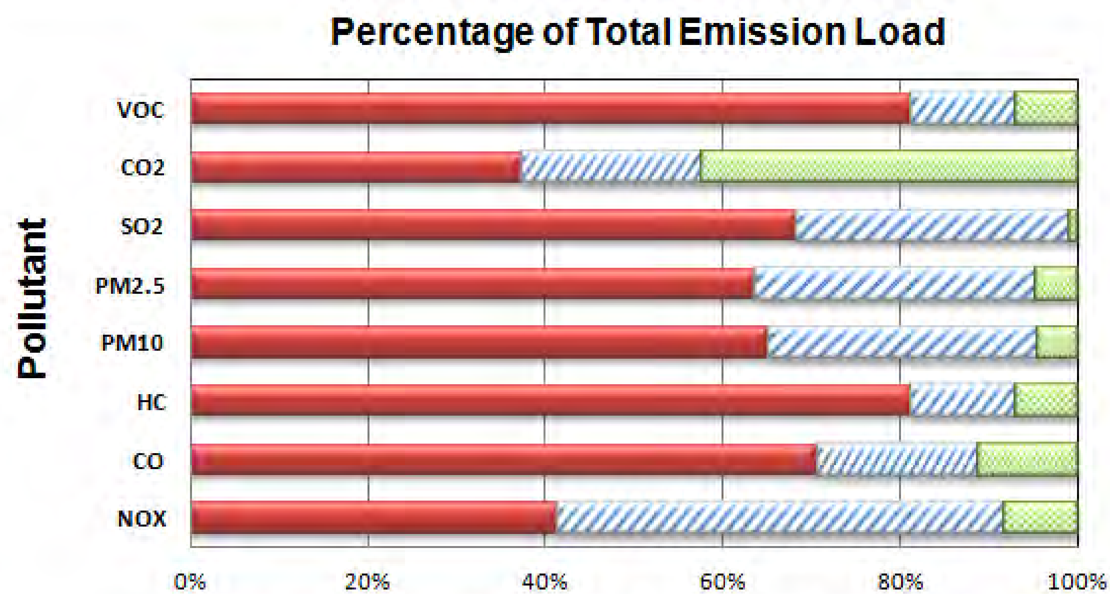
	NOX	CO	HC	PM10	PM2.5	SO2	CO2	VOC
Ocean Going Vessels	2,974	711	472	182	166	112	180,254	474
Harbor Fleet	1,949	186	67	86	83	62	101,807	67
Landside Emissions	260	91	27	12	12	1	132,823	27

Figure 5.14 Percent Emission Load Distribution by Source for Year 2030 and TSP Depth of 47 feet



	NOX	CO	HC	PM10	PM2.5	SO2	CO2	VOC
Ocean Going Vessels	1,724	773	510	200	182	124	199,230	513
Harbor Fleet	2,107	199	73	93	90	62	110,098	73
Landside Emissions	254	93	31	10	10	1	177,910	31

Figure 5.15 Percent Emission Load Distribution by Source for Year 2040 and TSP Depth of 47 feet



	NOX	CO	HC	PM10	PM2.5	SO2	CO2	VOC
Ocean Going Vessels	1,906	846	555	221	201	138	222,500	558
Harbor Fleet	2,301	215	80	103	99	62	120,218	80
Landside Emissions	374	133	47	15	15	2	251,035	47

6.0 FUTURE PLANS FOR PORT OF JACKSONVILLE

Taylor Engineering conducted a detailed air emission inventory and estimated the emission load for the Port of Jacksonville for existing conditions (baseline year of 2008) and future years. This effort is the first comprehensive emission inventory undertaken by JAXPORT and private terminals to support the Jacksonville Harbor Dredging Deepening project. As stated previously, in cases where data was unavailable, Taylor Engineering and JAXPORT used best professional judgment to fill the gaps in the data inventory. In future, JAXPORT plans to introduce protocols to gather appropriate data related to air emission inventory. By doing so, JAXPORT should be able to update the current detailed air emission inventory with the new collected dataset.

Taylor Engineering believes the emission load calculations performed for the harbor deepening study are conservative and do not include any emission-reducing solutions implemented by JAXPORT or private terminals. For example, JAXPORT's Blount Island Terminal recently installed diesel oxidation catalysts on its diesel-powered cranes to reduce pollutant emissions. JAXPORT estimates a 20 percent reduction in particulate matter, 50% reduction in hydrocarbons and 30% reduction in carbon monoxide loads from these cranes (JAXPORT Youtube video, 2012). JAXPORT plans to undertake similar modifications for similar equipment at Talleyrand terminals.

The emission load analysis for Port of Jacksonville shows that diesel-powered ocean-going vessels contribute the maximum load for most of the pollutants. Recently, JAXPORT's tenants announced that at least four ships calling at JAXPORT's Blount Island Terminal with over 100 vessels calls in a year at this terminal would be converted into LNG-powered vessels. LNG-powered ships would reduce the NO_x, PM10, CO_2 and SO_2 emissions significantly when compared with diesel powered ocean-going vessels. The future year's emission load calculations do not take into account these types of emission reduction measures. Therefore, Taylor Engineering believes that in reality the future year's emission loads would be lower than the estimated emission loads of this appendix.

7.0 REFERENCES

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ATTACHMENT A

VESSEL FLEET FORECAST FROM USACE – JACKSONVILLE DISTRICT

FLEET FORECAST FOR

NO ACTION ALTERNATIVE (WATER DEPTH - 40 FEET)

Terminal	**Blount Island**				
YEAR	**2020**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	147	63	140	351
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	430	-	-	-	431
General Cargo Ship	-	263	-	-	263
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	27	9	164	-	200
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	23	414	9	-	446

Terminal	**Dames Point**				
YEAR	**2020**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	15	15	-	30
Container Ship	0	0	110	200	310
Cruise Ship	2	-	36	-	38
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	6	-	-	6

Terminal	Talleyrand				
YEAR	**2020**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	2	1	-	5
Container Ship	0	153	62	0	214
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	101	-	-	101
Reefer Cargo Ship	15	-	-	-	15
RoRo Cargo Ship	1	7	8	-	16
Tanker	11	13	1	-	25
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	90	-	-	91

Terminal	Blount Island				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	180	95	250	524
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	432	-	-	-	432
General Cargo Ship	-	319	-	-	319
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	28	9	172	-	209
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	24	435	9	-	468

Terminal	Dames Point				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	171	355	526
Cruise Ship	2	-	38	-	40
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	186	90	0	276
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	123	-	-	123
Reefer Cargo Ship	16	-	-	-	16
RoRo Cargo Ship	1	7	9	-	17
Tanker	12	14	1	-	27
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	95	-	-	96

Terminal	Blount Island				
YEAR	2040				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	5	8	-	-	13
Container Ship	0	215	116	348	679
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	434	-	-	-	434
General Cargo Ship	-	374	-	-	374
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	30	10	181	-	221
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	25	457	10	-	492

Terminal	Dames Point				
YEAR	2040				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	209	496	705
Cruise Ship	2	-	40	-	42
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	223	110	0	333
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	144	-	-	144
Reefer Cargo Ship	17	-	-	-	17
RoRo Cargo Ship	2	8	9	-	19
Tanker	12	15	2	-	29
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	99	-	-	100

FLEET FORECAST WITH WATER DEPTH 44 FEET

Terminal	Blount Island Terminal				
YEAR	2020				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	147	35	131	313
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	427	-	-	-	427
General Cargo Ship	-	263	-	-	263
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	27	9	164	-	200
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	23	414	9	-	446

Terminal	Dames Point				
YEAR	2020				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	15	15	-	30
Container Ship	0	0	60	137	196
Cruise Ship	2	-	36	-	38
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	6	-	-	6

Terminal	Talleyrand Terminal				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	2	2	1	-	5
Container Ship	0	153	95	0	247
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	101	-	-	101
Reefer Cargo Ship	15	-	-	-	15
RoRo Cargo Ship	1	7	8	-	16
Tanker	11	13	1	-	25
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	90	-	-	91

Terminal	Blount Island Terminal				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	180	41	212	433
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	429	-	-	-	429
General Cargo Ship	-	319	-	-	319
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	28	9	172	-	209
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	24	435	9	-	468

Terminal	Dames Point Terminal				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	68	285	352
Cruise Ship	2	-	38	-	40
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand Terminal				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	186	111	0	297
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	123	-	-	123
Reefer Cargo Ship	16	-	-	-	16
RoRo Cargo Ship	1	7	9	-	17
Tanker	12	14	1	-	27
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	95	-	-	96

Terminal	Blount Island Terminal				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	5	8	-	-	13
Container Ship	0	215	34	285	535
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	431	-	-	-	431
General Cargo Ship	-	374	-	-	374
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	30	10	181	-	221
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	25	457	10	-	492

Terminal	Dames Point Terminal				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	53	434	487
Cruise Ship	2	-	40	-	42
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand Terminal				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	223	94	0	317
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	144	-	-	144
Reefer Cargo Ship	17	-	-	-	17
RoRo Cargo Ship	2	8	9	-	19
Tanker	12	15	2	-	29
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	99	-	-	100

FLEET FORECAST WITH WATER DEPTH 45 FEET

Terminal	Blount Island				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	147	35	127	309
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	427	-	-	-	427
General Cargo Ship	-	263	-	-	263
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	27	9	164	-	200
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	23	414	9	-	446

Terminal	Dames Point				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	15	15	-	30
Container Ship	0	0	59	134	193
Cruise Ship	2	-	36	-	38
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	6	-	-	6

Terminal	Talleyrand				
YEAR	**2020**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	2	1	-	5
Container Ship	0	153	95	0	247
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	101	-	-	101
Reefer Cargo Ship	15	-	-	-	15
RoRo Cargo Ship	1	7	8	-	16
Tanker	11	13	1	-	25
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	90	-	-	91

Terminal	Blount Island				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	180	41	205	425
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	429	-	-	-	429
General Cargo Ship	-	319	-	-	319
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	28	9	172	-	209
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	24	435	9	-	468

Terminal	Dames Point				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	68	273	341
Cruise Ship	2	-	38	-	40
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	186	111	0	297
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	123	-	-	123
Reefer Cargo Ship	16	-	-	-	16
RoRo Cargo Ship	1	7	9	-	17
Tanker	12	14	1	-	27
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	95	-	-	96

Terminal	Blount Island				
YEAR	2040				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	5	8	-	-	13
Container Ship	0	215	34	274	523
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	431	-	-	-	431
General Cargo Ship	-	374	-	-	374
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	30	10	181	-	221
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	25	457	10	-	492

Terminal	Dames Point				
YEAR	2040				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	53	414	467
Cruise Ship	2	-	40	-	42
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	2040				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	223	95	0	317
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	144	-	-	144
Reefer Cargo Ship	17	-	-	-	17
RoRo Cargo Ship	2	8	9	-	19
Tanker	12	15	2	-	29
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	99	-	-	100

FLEET FORECAST WITH WATER DEPTH 47 FEET

erminal	Blount Island				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	148	35	125	308
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	427	-	-	-	427
General Cargo Ship	-	263	-	-	263
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	27	9	164	-	200
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	23	414	9	-	446

Terminal	Dames Point				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	15	15	-	30
Container Ship	0	0	60	129	188
Cruise Ship	2	-	36	-	38
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	6	-	-	6

Terminal	Talleyrand				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	2	2	1	-	5
Container Ship	0	152	95	0	247
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	101	-	-	101
Reefer Cargo Ship	15	-	-	-	15
RoRo Cargo Ship	1	7	8	-	16
Tanker	11	13	1	-	25
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	90	-	-	91

Terminal	Blount Island				
YEAR	2030				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	180	41	199	420
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	429	-	-	-	429
General Cargo Ship	-	319	-	-	319
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	28	9	172	-	209
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	24	435	9	-	468

Terminal	Dames Point				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	68	260	328
Cruise Ship	2	-	38	-	40
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	186	111	0	296
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	123	-	-	123
Reefer Cargo Ship	16	-	-	-	16
RoRo Cargo Ship	1	7	9	-	17
Tanker	12	14	1	-	27
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	95	-	-	96

Terminal	Blount Island				
YEAR	2040				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	5	8	-	-	13
Container Ship	0	216	34	264	514
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	431	-	-	-	431
General Cargo Ship	-	374	-	-	374
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	30	10	181	-	221
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	25	457	10	-	492

Terminal	Dames Point				
YEAR	2040				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	53	390	444
Cruise Ship	2	-	40	-	42
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand Terminal				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	222	95	0	317
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	144	-	-	144
Reefer Cargo Ship	17	-	-	-	17
RoRo Cargo Ship	2	8	9	-	19
Tanker	12	15	2	-	29
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	99	-	-	100

FLEET FORECAST WITH WATER DEPTH 48 FEET

Terminal	Blount Island				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	146	35	123	304
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	427	-	-	-	427
General Cargo Ship	-	263	-	-	263
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	27	9	164	-	200
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	23	414	9	-	446

Terminal	Dames Point				
YEAR	2020				
Category	Handysize	SubPanamax	Panamax	PostPanamax	TOTAL
Bulk Carrier Ship	-	15	15	-	30
Container Ship	0	0	59	129	188
Cruise Ship	2	-	36	-	38
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	6	-	-	6

Terminal	Talleyrand				
YEAR	**2020**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	2	1	-	5
Container Ship	0	154	95	0	248
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	101	-	-	101
Reefer Cargo Ship	15	-	-	-	15
RoRo Cargo Ship	1	7	8	-	16
Tanker	11	13	1	-	25
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	90	-	-	91

Terminal	Blount Island				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	4	7	-	-	11
Container Ship	0	178	41	197	416
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	429	-	-	-	429
General Cargo Ship	-	319	-	-	319
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	28	9	172	-	209
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	24	435	9	-	468

Terminal	Dames Point				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	68	259	327
Cruise Ship	2	-	38	-	40
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand				
YEAR	**2030**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	188	111	0	298
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	123	-	-	123
Reefer Cargo Ship	16	-	-	-	16
RoRo Cargo Ship	1	7	9	-	17
Tanker	12	14	1	-	27
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	95	-	-	96

Terminal	**Blount Island Terminal**				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	5	8	-	-	13
Container Ship	0	214	34	261	508
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	431	-	-	-	431
General Cargo Ship	-	374	-	-	374
Reefer Cargo Ship	2	-	-	-	2
RoRo Cargo Ship	30	10	181	-	221
Tanker	1	1	-	-	2
Tanker Barge	2	5	-	-	7
Vehicle Carrier Ship	25	457	10	-	492

Terminal	**Dames Point Terminal**				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	-	16	16	-	32
Container Ship	0	0	53	388	442
Cruise Ship	2	-	40	-	42
Dry Cargo Barge	0	-	-	-	-
General Cargo Ship	-	0	-	-	-
Reefer Cargo Ship	-	-	-	-	-
RoRo Cargo Ship	-	-	-	-	-
Tanker	-	-	-	-	-
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	-	7	-	-	7

Terminal	Talleyrand Terminal				
YEAR	**2040**				
Category	**Handysize**	**SubPanamax**	**Panamax**	**PostPanamax**	**TOTAL**
Bulk Carrier Ship	2	3	1	-	6
Container Ship	0	224	95	0	319
Cruise Ship	-	-	-	-	-
Dry Cargo Barge	58	-	-	-	58
General Cargo Ship	-	144	-	-	144
Reefer Cargo Ship	17	-	-	-	17
RoRo Cargo Ship	2	8	9	-	19
Tanker	12	15	2	-	29
Tanker Barge	-	-	-	-	-
Vehicle Carrier Ship	1	99	-	-	100

ATTACHMENT B

SPREADSHEET WITH DETAILED EMISSION LOAD CALCULATIONS FOR PORT OF JACKSONVILLE ON A CD